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Computer Age

SEPTEMBER 1980 ISSUE 10 60p

- Getting to grips
- Algorithmic design
- Electronic Games
- Book-keeping package

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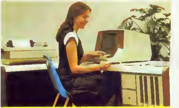

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Cover Paper Serpent
by S L Sant

Editorial

Hamburgers and Computers

UKITO stands for the United Kingdom Information Technology Organisation — British Firms allied to represent the indigenous computer industry. It has just been formed to urge the Government to, in essence, continue and expand its policy of support for British owned computer companies. But very soon the General Agreement on Tariffs and Trade (GATT) code will come into force — throwing tenders open. UKITO feels that Japanese and American computer manufacturers are heavily subsidised one way or another and that their resulting competition is unfair. Companies outside UKITO disagree and emphasise the benefits of open competition. Furthermore a company like Burroughs stresses that it has been in Britain for a long time and regards itself as being British.

There is no question as to the sincerity of the arguments on both sides, arguments that are reaching a strident pitch now that a £150 million computerisation project for the Inland Revenue is looming. I am inclined to stay on the side of the angels and not rush into an area that has more pitfalls than solid ground. My instinct is that a classic British compromise will be reached.

Now we come to the hamburgers. The computer industry is full of all types of organisations and associations – hobby groups, educational groups, proselytising groups. They represent vested interests and rightly so; anyone who claims to be objective is flattering himself and deceiving others. The hope is that, with the free airing of so many viewpoints, a balance results. But it would be a good idea if all these groups came together and considered the needs of the customer, the needs of the industry — in terms of training people. In the USA, Macdonalds has a hamburger 'university' where it trains its personnel – could not all sides of industry here get together and fund a training college? And the obvious body to set up and administer the college already exists. It would, because of its undoubted authority and the respect it commands, be readily accepted. I am talking about the British Computer Society.

Meyer N Solomon
Editor

Brand News

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CHIPS HERE AND THERE

This is a second full chapter of the author's book The Micro Revolution *published by Fontana at £1 50*

The silicon chip is becoming all-pervasive in industry and commerce the universal machine that can revitalize virtually all other machines the 1980s equivalent of the nuts and bolts of the first Industrial Revolution It would be impossible therefore in one article to provide even a bare outline of the variety of employment the microprocessor has found in its first decade of work But here are a few examples in the fields of transport and energy

The use of the computer in transport began with variations on the classical information network – improving traffic flow by controlling city traffic lights helping airport flight handling organizing railway signalling – and by taking the weight of routine work from the shoulders of the airline pilot and the ship's officer The impetus to move the microcomputer down to the individual car and lorry has come from the increasing need for fuel economy and the demands for control of the poisonous fumes of the internal combustion engine

But the use of the microprocessor to improve the efficiency of the cheaper car models through the control of ignition and fuel timing and throttle and gear selection, has been slower than the forecasts of both the semi-conductor industry and the car manufacturers The problems of economically mating the delicacy of electronics to the crudity of the internal combustion engine have proved deeper than expected

In luxury cars the micro has been used in more gimmicky ways to provide the driver with wider dashboard information – digital speedometers clocks and radio controls electronic control of air conditioning calculations of distances left on a particular journey and warning messages about fuel consumption

Where cost is not the prime control, spectacular results have been achieved For instance microcomputers have been

put aboard formula one racing cars where of course they encounter extremes of acceleration vibration high temperatures and electrical interference There they have been used not only to improve engine efficiency but also to monitor (every fifth of a second) the suspension displacement on each wheel, the forward and braking accelerations, the lateral acceleration on corners the road speed and the chassis roll After practice laps when the cars go into the pits the onboard computer is connected to a printer and the data – in graphs as well as tabular form – is then available to determine quickly and accurately what adjustments to make to improve the car's performance on that particular circuit

The next logical step is onboard computer adjustments during races And after that: whither the driver? Some computer scientists have forecast that the driverless collision-avoiding car could be a practical proposition by 1985 but motor-racing people deny that this will destroy their sport They say that in racing the driver puts in work that is still virtually impossible to describe mathematically let alone replace by electronics Karl Kempf, technical consultant to the Tyrrell team says 'When Fangio and Stirling Moss were driving, it was seventy per cent the driver thirty per cent the car Now it's fifty-fifty But there will be no way to replace the man for fifty years

In public transport, however, it's a different story The ultimate reason why underground trains today have drivers cabins with people sitting in them is psychological Computer-run driverless trains have been introduced experimentally, for urban transport in Japan and the United States, and have gone beyond the experimental at airports with terminals a long way from the departure lounges Systems designed by Westinghouse which use automatic trains travelling at thirty miles an hour along concrete roadways, to which they are locked by rubber-tyred guidewheels are used at Tampa Seattle, Miami and Atlanta airports and should be in operation at Gatwick Airport London, in the early 1980s

In Germany, a microprocessor system which takes over the main-line railway driver's functions – observing signals controlling speed and responding to radio instructions – is due to be tested on the Hamburg-Bremen line next year, but with the driver staying aboard to watch the computers working That system has triple security: two microcomputers working simultaneously, checking each other's performance, while a third stands by to take over if one of the others fails The eventual aim is to use computer control for the 180 mph trains The method has been tested extensively on goods trains in German marshalling yards

Improving bus services

West Germany has also been a leader in using the computer to improve bus services Two dial-a-bus experiments which give public transport the flexibility of the taxi have been operating since 1978 – one in Berlin, for the disabled only and the

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other, in Hanover, for the general public. The Berlin service of forty small buses is being expanded in steps to provide, by 1981, a hundred buses covering West Berlin and offering door-to-door transport for all the city's 8 000 handicapped people. The Berlin buses are called by phone or by advanced booking through the mail. They follow no fixed schedule. The driver is in radio contact with the computer control centre (which is run by disabled people). The computer selects the best bus to go to each call, bills the customer, and produces operational statistics for management use.

The Hanover public service is more complicated. You can call a bus from roadside computer terminals at twenty-two bus stops. The terminal gives you a ticket which states the fare paid, when the bus will arrive to pick you up, how long your journey will take, where you change if you need to go on to another old-fashioned bus service – and when *that* bus should arrive, and how long *that* journey will take. Messerschmitt, who devised the system, argue that it could be of particular value in suburban and rural areas, where public transport could be rekindled profitably, fulfilling the social objective and the economic objective.

Total computer control in the air is an issue even more emotive than computers driving cars and trains. One British expert – Les Walker, of the engine electronics division of Lucas – forecasts that helicopters piloted by microcomputers could be flying by 1990 or, possibly, 1985. The system Lucas are working on replaces the pilot's controls with a push-button panel. It is based on microprocessor control of the engine – and, of course, a helicopter's engine is, in essence, its wings as well. Therefore, says Walker, the helicopter is an easier option for total automation than the winged aircraft. There is less demand on those seat-of-the-pants judgements of the human, analog kind that are difficult to translate into the digital demands of the computer.

Walker foresees pre-programmed flights and, more immediately, simpler flying by human pushing of the buttons so that the business executive could more easily become his own pilot of a company helicopter. Such an idea shocks the UK Civil Aviation Authority, who grimly reply that such a pilot would still be required to do 200 hours of airborne training to get a licence – and they would not licence a computer, however much airline pilots now rely on them.

Nevertheless, plans are being made for the new European A310 airbus (due to be flying by March 1982) to carry microprocessors empowered to disobey the captain. These silicon chips will be in the wings, controlling the motors which move the flaps and slats (flaps are on the trailing edge of the wing and drop to increase lift, slats are on the leading edge and extend to increase lift).

Each of the microprocessors controlling these movements will have a back up chip monitoring it. Both front line and reserve have to agree – if they don't, they will tell the captain. Should the flight crew order them to do something against the rules – like withdrawing slats below a safe airspeed – they will reject the order and tell the captain why. But if the crew want deliberately to try the unorthodox in an emergency, the chips will do as they are told when the order is repeated.

This automation goes further in military aviation. Fast, low level strike aircraft carry computers that respond to touch. With the lightest of fingertip touches by the pilot they can act faster on split-second decisions than computers which take orders through buttons or voice commands. These 'touch mask' devices use infra-red light beams which crisscross the pilot's main display screen. A finger placed on the screen will intercept two beams at right angles and thus alert the computer. A point on the mask can order an emergency turn: one touch and the computer checks the maximum force that pilot and plane can resist, then operates the controls to produce the tightest possible turn. Such masks can also be used to team with a map display on the screen: if a point on the map is touched, the computer will put the aircraft on course for that new destination.

Microelectronics has brought the pilotless aircraft to reality in frightening fashion, through the Cruise missiles that speed low across country, fitting their flight to the contours of the landscape.

Some optimists argue that the military's reliance on computer technology could remove the threat of nuclear war. This argument is based on the use of computer modelling and simulation as an essential component of strategic planning. (Just as in business use of computer modelling, the known facts are fed to the computer which then calculates the effect of adding various contingencies to the equation. By this means a business can assess more accurately what is likely to happen to its sales next year if, say, Value Added Tax is lowered while two new competitors join the contest.) Chris Evans, in his book *The Mighty Micro*, concludes that the United States' decision to withdraw from Vietnam was based on computer predictions of defeat. But, of course, such computer analysis depends on the accuracy and objectivity of the man provided data on which it is based.

A study made for the Department of Industry by Iann Barron and Ray Curnow is more pessimistic. It points out the significance that the huge American lead over the Soviet Union in microelectronics has had for the balance of power and reminds us that the current stage, in which the cheap microprocessor is available in quantity worldwide, could shift that balance. 'It is clearly impossible for the US to control the distribution of components costing only a few dollars, and there can be little doubt that the Russian answer to the Cruise missile will use American microprocessors as the control element. . . . The use of information technology is changing many of the assumptions on which the current balance of power is based, and this must be a destabilizing influence.'

The Energy front

On the energy front at least, there can be no doubts about the way man has employed microelectronics. Using computers to control office and factory environments has saved hugely on power. For many years computers have been used to run the heating, lighting, air conditioning and night-time burglar and fire alarms in office blocks. They can be programmed for a year in advance with details about days and hours when the building is in use and the temperatures required. They then learn from their own experience to fine-tune that programming to deal with unseasonable changes in the weather. But – the old story – they were costly till the chip matured. Now they are an economic proposition for smaller buildings – small-town schools, for instance. Micro-run systems, costing between £1 000 and £2 000, can save up to forty per cent on heating bills.

The semi conductor industry is also involved in solar energy. The photo-voltaic method of harvesting the sun's energy (using silicon cells, like the wafers on which chips are built, to produce direct electric current) is undergoing one of its biggest tests in Phoenix, Arizona, in a solar energy field spread over twelve acres. There is now serious discussion about placing such huge fields in orbit around the earth.

But the Arizona example indicates what a long research road there is to travel before the oil finally runs out; the 500-kilowatt plant at Phoenix Airport, which is costing £4.5 millions, will provide only part of the power required for the airport's new terminal building.

The Arizona project, one of many similar large-scale trials, has been designed by the microelectronics company Motorola, who have one of their main bases in Phoenix. They have teamed with the state and city authorities in an attempt to win a major share of the US Department of Energy's solar programme. The Department is funding competitive experiments to bring the cost of solar power down to £1 a watt by 1983 and 50 pence a watt by 1990. These targets compare with a 1977 cost of £10 a watt and a 1979 cost of £5. William O'Connor, director of Motorola's solar energy operations, describes the targets as tough but attainable. He estimates that in the oven areas of the southern United States, Australia, and the Middle East, solar energy could meet fifty per cent of requirements – if you went hell for leather on current technology.

The twelve-acre field at Phoenix Airport has 14,250 bowl-like concentrators to catch the light. Each is thirty inches across and eleven inches deep. Sunlight is reflected from the curved bottom surface up to a smaller reflecting surface at the middle and top of the bowl – and from there down to the working heart, the three inch wafer of silicon, the solar cell. The concentrators are mounted, like an army of searchlights, on seventy-five arrays, and a computer constantly tilts those arrays so that they track the sun throughout the day. Arizona is an ideal test bed. The Sonoran desert region ranks second in summer heat only to Death Valley, with surface soil temperatures in summer exceeding 150 degrees Fahrenheit.

In exploiting these advantages, Motorola started small. In 1977 they produced an array of forty eight silicon cells to power a traffic counter across a six lane highway in Glendale, Arizona. It provided eight watts or more, enough to charge a reserve battery and keep the counters ticking off the cars through the night. The next – and cost-effective – stage was to supply power at small, remote installations, like radio repeater stations on mountain tops. After that, villages: silicon cells were used to provide small generators for indian villages in the Arizona desert. One of these villages previously had only enough power to keep a water pump going, now nearly forty homes there have electric lights and refrigerators, plus a washing machine or two.

Finally, here are a few illustrations of the ubiquity of the silicon chip, of the way in which it is helping to solve old problems and to spark new ideas in totally unconnected areas.

First, music: for five years a small company called Pulse Designs, run by an engineer and his musician son from the family home at Ashtead, in Surrey, sold a metronome driven by old-fashioned transistors. The feedback from customers showed a demand for something more versatile. So the son, William Watson, wrote a computer program to clarify requirements. Then he matched a microprocessor with a quartz crystal oscillator, to maintain perfect pitch, and thus transformed the metronome into a 'universal rehearsal aid'. The battery-run machine thus concocted includes a digital display to indicate normal beat speed, accented first beat in the bar, cross rhythms, three coloured lights with (or without) an audible tick, extra fast speeds for simple or compound time, tempo display, and an ear plug.

The chip is also being used, alarmingly, to make synthetic music. General Instrument Microelectronics have produced a single chip pre-programmed to generate twenty-five short tunes. If you want to program it yourself, there are 251 notes to play with. The company blissfully suggests that the chip should be connected to different bell pushes on each door of our homes. Each member of the family would then have his own door chime call tune, with other codes for the milkman and the neighbours. The standard pre-programmed tunes – selected for their international acceptance — range from 'Jingle Bells' to 'God Save the Queen'.

> *"The Arizona example indicates what a long research road there is to travel before the oil finally runs out."*

Next, the chip underwater – miniaturizing the submarine. The microprocessor has made possible a variety of flying saucer shaped, unmanned underwater inspection craft, many of them less than a metre across. They are designed to work in conditions that would be dicey for the diver – rough seas or zero visibility. They are often propellerless, being driven by an electrical pump, and their batteries of cameras include high resolution and low-light equipment. The microcomputer on board interprets signals from the control console of the human operator above, to change speed and direction, but, in zero visibility such a submarine can manage on its own – it assesses information from the craft's magnetic compass and gyro and projects its own navigation target, which the operator aboard ship can follow on his video screen.

If the craft is operating in fast currents, the operator can maintain its position in the water by pressing a hold button. The microcomputer will then compensate for the effects of the current, keeping the craft on station without the operator's help. The hold system can also be used to keep a steady course at speed. (That is a micro version of computer systems that have been used for a long time to keep oil platforms or supply ships over a given spot on the ocean bed, where the sea is too deep or too rough for an anchor. The computer directs side-thrusting propellers to offset instantly the changing impact of wind and current.)

The chip is also helping the human diver. Mervyn Jack, a lecturer at Edinburgh University, has designed a microelectronic device to unscramble the speech distortions that bedevil a deep-sea diver. It opens the prospect of making communication cables obsolete. The distortions are caused by the mixture of helium and oxygen that divers have to breathe. Unscrambling equipment, bigger than a television set, is needed on the control ship before diver can talk to diver or to the surface. Jack's unscrambler is only eight inches by four inches, by two inches, and runs on a battery. He is now working on ways of getting all the work done by a single chip, then the whole thing would go into a matchbox.

Jack's first version maintains a high quality of speech reproduction, but its main significance lies in the use of such a portable decoder to provide the diver with radio. Then, if the lifeline to diver or diving bell were cut, divers could stay in contact and therefore make rescue easier.

Now, one example from among the many of the ways in which the chip revolutionizes the routine tasks of industry: in this case, testing springs. The traditional mechanical method of testing springs is to put a sample into a machine, which compresses it, and then to measure the load on the spring and its deflection by a slow series of gradual compressions, readings from those compressions, then more compressions, then more readings. A chip-run machine evolved at the Cranfield Institute of Technology does all that and more in a few seconds. The operator tells the microcomputer what he wants to know. The computer instructs a high-pressure hydraulic cylinder, which compresses and relaxes the spring just once, and from those few seconds, measuring instruments feed a host of readings to the computer.

The chip is also hastening the arrival of computer animation. This combines the drawing-on-the-screen uses of computer aided design with the graphic capabilities used in business systems to produce diagrams and graphs from raw statistics. Such computer-produced graphics are now beginning to appear in television commercials and in cartoon films – where the computer can take the artist's definition of the funny walk and reproduce it to avoid the expense, tedium and time-wasting of redrawing every step of the character's progress from point A to point B.

Then, of course, there is the wide and growing variety of usually puerile but obsessional computer games – screen tennis, maze puzzles, spacecraft piloting, and the like. These serve purposes beyond the trivial: they make the computer familiar to the uninitiated, they provide a greater commercial impetus for research into voice communication with the computer, and they may also help to bring more attention to the often unheeded problems of designing computer systems with people in mind. ■

- *Peter Large is the Technology Correspondent of* The Guardian

What will you do with 12-year-old programmers when they reach 16?

Any microcomputer is a major investment for an educational establishment. Many potential users feel that a BASIC only computer is ample for their needs. That may be true today but with computer education starting so early you may in a surprisingly short time find you want more than current implementations of BASIC.

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Given good hardware, software availability completely determines the flexibility and usefulness of your system. There is absolutely no question that a Z80 based micro-computer which uses the industry standard CP/M* disk operating system has several times more software on the market available to it than non CP/M computers.

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If you don't

Remember that professionals writing packages for your cassette system will themselves often use a disk 380Z and the power of their tools will influence what they produce.

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380Z BASIC is not frozen in ROM. An enhanced BASIC could be loaded in mid 1980 and a BASIC with structured features sometime later.

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Our scientific graphics was produced for the professional user. Interest in it for classroom use has been surprising.

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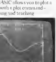
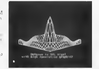


It is worth remembering too that neither our low resolution graphics nor our optional scientific (high resolution) graphics has any limiting effect on your memory usage, and in both you can



freely mix upper and lower case text and diagrams.

Mains noise can cause system crashes which result in loss of programs and data. All current 380Zs include a mains filter which significantly reduces the chances of this happening.

Don't buy a 380Z on patriotic grounds

Please only buy it if you would have bought it anyway. But remember because it is designed and manufactured here you are bound to have better access to us for influence and help than if we were on the other side of an ocean.

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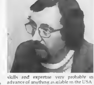

Good news — by accident or design we're ahead. Surprised? Read on

Ask most Americans for a one line answer to the question "What thinkest thou of Great Britain?" and it will usually be one of the many variations on the theme "A great li'l old country that's five hours ahead of the USA and ten years behind."

Now some patriots consider that this is going, perhaps, just a little too far and represents a glib value judgement based on just one trifling national characteristic — namely our inability to realise that we could have made money out of the ideas generated in the country until it has been proved beyond all reasonable doubt that it is possible, by someone else — usually an American. The original ideas however have often been ours, dammit!

Strangely enough the same can be said for the personal computer market and — even more strangely — the roles have to some extent been reversed between the two countries. This is not to suggest that the personal computer was an idea of UK origin and only developed in the USA by default (though it wouldn't necessarily surprise me if that indeed turned out to be the case); it is more a statement that the USA, having come up with a good idea, was then shown what to really do with it by the bright sparks of the UK.

I'll explain. Earlier this year I went on one of those "business" trips doing most of the things people who go on such trips do. I found myself in New Orleans, which was probably fortunate because that is where I had intended to be. My target was one of the foremost conferences on the subject of personal computers either side of the Mason/Dixon Line. A conference organised by one Ben Rose and held immediately in sequence with another conference on the semiconductor industry. These two events attract more high technology company presidents per square foot than any other.

Now, in the personal computer conference, the leaders of the US industry — and therefore by definition the world industry — announced that they had made a startling discovery. The real future market for small stand-alone personal microcomputers (and that's a definition that should cover most options) is wait for it Britain small businesses.

Yes, the market the UK dealers, distributors and manufacturers have been happily selling to, and developing methods of servicing for over the past eighteen months to two years, with considerable success, has now become official. The US manufacturers say it exists, and, furthermore, they want a big piece of it.

Now it can certainly be argued that as they supply the vast majority of UK distributors and dealers with stock anyway they have a goodly slice already, and as far as it goes this is true. What they don't necessarily have, as yet, is the one thing the UK dealers and distributors do have — expertise in selling to this particular market.

To some extent this expertise has been developed the hard way, by trial and error (with a fair proportion of the latter in many cases), and the knowledge thus won has been hard-earned. I have written before on the difficulties of selling systems in the UK, especially at the dealer level — the problems of hardware and software support, the lack of good software, the financial problems, and the need to find a solution to a customer's problems when he has barely established in his own mind what those problems actually are.

Yet despite these problems the UK has managed to become a significant portion of the world market for microcomputer systems. That market is being estimated at around $1,000 million worldwide, with Europe representing some 25% of that. The UK itself represents some 25% of the European market, which in round figures means some £30 millions worth of business, based to a not-inconsiderable degree on selling microcomputer systems to small businesses.

To some extent, the UK industry's expertise in selling to the small businessman has been a Hobson's Choice, the hobbyist sector of the marketplace never having been large enough to support a significant amount of business. The reasons for that have been well charted — the major one being our lack of disposable income, unlike our ex colony on the other side of the Atlantic. Whatever the reason, it has led to the development of skills and expertise very probably in advance of anything available in the USA. Those skills cover most of the aspects of *user problem solving*, including that all important factor — software.

Now that the Americans seem to have woken up to the fact that the small business market exists it would seem an appropriate time for participants in the UK industry to perhaps find ways of exploiting both their talent and their leadership. It is an opportunity that will not last for long, for the Americans will rapidly catch up, and overtake, given the chance. With the introduction of Apple III and the Commodore 8032 large screen Pet — joining the already introduced Model II of the TRS 80 from Tandy — the hardware for them to work with is now available (no need to do the clever business system tricks some Brits managed to pull off with an 8K Pet).

One of the industry observers in the US who has pointed out the significance of the small business sector to the manufacturer is Robert Wickham, President of Vantage Research, a company — based in the Santa Clara valley — that specialises in personal computer market research.

Wickham was one of the key speakers at the Rosner Forum, and he pointed to the fact that, even in the US, there was by mid-1979 a definable trend towards what he termed 'up market' personal computers that were in fact being used in the business environment, though the manufacturers themselves failed to spot it. With the advent of the newer systems, however, he said that he could perceive another new market. This he christened the Office Computer Market — not quite a small business system, which he feels is still the domain of the minicomputer manufacturers. This is a market that may well sound familiar to many UK distributors and dealers!

It is also a market where he predicts considerable activity from a growing number of manufacturers, and therefore by definition some hard and possibly dangerous in-fighting as they each pitch for a significant patch. The number of manufacturers in this area will be swelled, he feels, not only by the existing mainframe and minicomputer companies moving down market with their own or

Viewpoint

bought in products (Ohio Scientific having signed a deal with an unnamed mainframe company to licence the sale of Challenger systems as new low end equipment according to Ohio president Charnty Chieky) but also by the low low-end consumer-oriented manufacturers moving up. This will happen he said because the consumer market just doesn't really exist anymore

One or two other interesting facts emerged from Wickham's contribution to the conference including an estimation that the worldwide installed base of personal computers was 1 250 000 units of which 500 000 were sold last year

Of more significance perhaps were his figures for the average selling prices for personal computer systems. Despite what the adverts say about being able to buy such amazing computing power for only 22 pence in practice it just ain't so

According to Wickham the ASP (average selling price) for systems sold into business applications in the US is $14 200. Professional users are paying $7 000 schools and colleges $4 000 home users around $2 500 and industrial users $10 500. Even with the generally lower prices charged for systems in that country everybody seems to be paying much more than the adverts would suggest they need to

For the future he outlined one major new market opportunity seen for the American manufacturers and their Office Computers. This is the possibility of the industry getting very large multiple orders from the top Fortune 500 companies. He sees these companies wanting to order vast quantities of small multi function work station systems. These will need a strong organisation orientation rather than being dedicated to the needs of a particular individual

Nor surprisingly this may also sound somewhat familiar to many people in the UK industry ■

•Martin Banks is editor of Microcomputer Analysis a Mackintosh publication

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THE COMPUTER PROGRAM(ME)

This month I'd like to present four scenarios each describing something that might be possible with computers in art or the arts Whilst I hope to explore a few issues that are presently exercising me, my more concrete goal is that I want to do each of the four things over the next year

My usual way of working is that I shout my mouth off about something that's on my mind so that I have actually to do it or else look pretty stupid It's like deadlines for magazines but with social rather than temporal pressure

It does work – one morning a few years ago I woke up and told the first three people I encountered that I was going to hitch hike from the Arctic to the equator I made it from Alaska to Mexico, and have the photos and brain damage to prove it

Before committing myself to further lunacies, however let me announce the winner of the Gambia competition that I set in issue 4 under the heading Desert Island Floppy Discs

This is in itself fairly lunatic the winning entry was an interpreter' (actually written in BASIC) using Reverse Gambian Notation and sundry peculiar syntactic abominations devised by Nick Cutler who gets the 50 Butut Gambian coin, as promised I must declare I think that Nick is not unknown to me we taught at the same Open University Summer School last year

I well remember a most startling incident in a bar where owing to the lascivious attentions of certain persons who kept pressing, amongst other things drinks upon us we catastrophically (in the mathematical sense) changed from being humans into computers, and tried to program each other This is what doctors call being pissed as a newt of course but it scared a roomful of people off number crunching computers for life — always a pleasure

Anyway to the four futures Each must become reality by this time next year don't let me forget One question to be asked of them – are they changed qualitatively or quantitatively by virtue of their involving a computer? Is there a discernible change because of its use as a tool or does it go deeper?

The opening graphics (computer generated but ever so subtle – you might not guess a computer had been involved) give the title 'The Computer Program(me) The last two letters flash on and off making the word belong alternately to the domains of computer and tv

A magazine programme dealing with weird and wonderful uses of computers, how to program reviews of popular makes computers in schools future trends, philosophy science fictions The programme will entertain, educate and above all demystify (yes) and therefore change

Computers in the studio will show and run various programs There will be news of exhibitions etc The programme will run for *half* an hour every week It will delve into areas such as the Police National Computer Prestel medical uses traffic light control art, guided missiles design music, shopping and offices

And all the time the program(me) will act as a *model* of a computer program What happens will be interactively determined in part by feedback from the real world of people phoning in, an audience etc One main theme will emerge *what do uses of computers tell us about our world?*

The Rock Band

OK, I want to get a singing computer The words of songs will be programmed in, probably phonetically I might even use the machine to help compose the words and music There is a speech synthesizer available now, which will not only produce the spoken words but which can also vary their speed and pitch I would want to alter that device so that these parameters, too, can be controlled from or via the computer, which will then be singing

The output from the synthesizer will of course be amplified and subjected to the usual electronic devices such as echo phase and so on It might also be linked to a Vocoder a device that uses the shape of the speech to in effect make instruments (real or electronically imagined) sing

An example of a song it will sing

Computer	*When all is disgust I turn to that which cannot rust –*
Chorus	*and simulate some safety*
Computer	*No sexism there no skin no eyes no clothes no hair – nowhere –*
Chorus	*I turn to my computer*

The Thesaurus

Roget's Thesaurus is a wonderful book Nearly everyone who writes for money or love uses it at some time When lost for a *really good* word meaning 'bad (as in 'that was a bad meeting) the Thesaurus can help one discover the joys of being able to say that it was 'deeply appalling oafish' or corybantic'

More than this by grouping words according to proximity of meaning it allows one to gain an insight into dynamic processes as well as the static heterogeneity multifariousness and polymorphic parallelism of the English language if you know what I mean

Thus you can trace a path between one word and another to see what nodes are passed what concepts thrown up 'Design and 'revolution coincide at change', for example while design and politics give plan But the three words design, 'existence and truth give a bi-pole involving both creation uniqueness, transcendence' *and* unity equality, oneness, not distinguish

This should be done on a computer, almost as a video game, with a subset (if the whole's too much) of the Thesaurus on a floppy disc To play the Thesaurus game, you just start thinking There are many such games to be played

The Art Gallery

I propose the following a small computer driving a plotting device – X Y plotter or more adventurously a turtle-like marker roaming over a large sheet of paper on the gallery floor, leaving a track The computer would be producing "Computer Art and can that have three quotes around it please so that we all know *yes indeed* the stuff that's being referred to

Linked to the machine will be a bicycle in a structure which will not let it ride away, but rather will monitor the wholehearted energy of any person pedalling, and will feed that information to the computer

Simply the faster you pedal the *less* drawing is produced

I thank you ■

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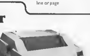

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Knud Frederiksen ECSA chairman The world revenue for our industry this year will rise to 20 billion dollars giving employment to half a million people

WHEN THE MIGHTY MEET

What goes on when some very high powered people in the data processing industry get together? Boris Sedacca went to one such gathering where he let the mighty do the talking and kept his tongue in his cheek

Knud Frederikson *is the president of IDC Data* Jerry Dreyer *is Adapso s executive vice president* Alvin Toffler *is a brilliant futurist* Lars Olof Bjoerskaen *is of the Swedish company Industri data* Theodore Levitt *is a professor at Harvard University (graduate school of business administration)* James Tillinghast *is a database specialist at Intel* John Imlay *is chairman of Management Science America* Robert Wessman *is a senior vice president of Adapso (Association of Data Processing Organisations)* *Also receiving honourable mentions an, an elephant and a killer whale*

Photographs in this article are by the author

In late June this year, over 1 000 people from 40 countries converged on the city of San Francisco on the American west coast to talk about data processing

The event, the World Computing Services Industry Congress II, was a high powered affair in itself but the organisers saw fit for some uncomputable reason to invite former US President Gerald Ford to open the congress

They also invited Art Buchwald the famous humourist and Washington columnist, and Alvin Toffler, author of 'Futureshock'

The relevance of Ford's Soviet-bashing at a computer conference raised some eyebrows among the delegates, although some found his talk illuminating

The reactions ranged from mild scepticism to outright mockery At a later session on human relations, to which I will return further on, some European put forward the question as to whether the US government was looking into the union aspect of the computer industry

To which Phil Dorn one of the better known industry pundits, replied 'You heard the answer this morning from the ex-President of the United States – he does not even know what information policy is

The congress was organised by the Association of Data Proressing Services Organisations (Adapso) a body similar to our own Computing Services Association but more aggressive and exclusive

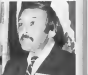
Adapso is constantly fighting to exclude the banks, telecommunications common carriers and professional accountancy firms (which invariably have a consultancy arm) from an involvement in the computer services industry as a secondary function that could thereby abuse their competitive position and cross subsidise their computer services activities

It is currently suing Citibank of New York in a Federal Court over offering general computer services and challenging Citicorp's application to form Citishare to offer general computer services to the public

The organisation of the congress could not be faulted although there was somewhat of a fracas over the attendance of the foreign press There were only two foreign journalists both (including myself) from Britain The reason for this? Foreign journalists had to pay $100 to attend the congress whereas US journalists could get in for free

Lars Olof Bjoerskaen We want to export our union problems

Alvin Toffler We are all [illegible] I doubt if there is anyone here without a watch



Jerry Dreyer In 1979 industry revenue in the United States jumped 22% from $7 8 billion to $9 5 billion

James Tillinghast — The problem of the 80s will be to provide electronic solutions by higher level system integration

As foreign journalists would have to pay their hotel bills and air fare, the net effect seemed to be of a world congress chasing away the world press. As it turned out, the organisers refunded the money to the other journalist who had paid in advance.

Each day the organisers distributed a four-page tabloid newsletter reporting on the previous day's events, expertly laid out in *Computerworld* style and complete with photographs. All the conferences were recorded and available the next day on cassette from a recording company brought in specially for the job. Everything was worked out to the last detail.

At the session on 'union relations' where all the speakers were from Europe, one of the delegates asked why union relations did not appear to be such an issue in the United States, at which point, Phil Dorn, a leading consultant and IBM-watcher, replied "You keep the problem in Europe – please," to howls of laughter from the audience.

"No, we always want to export" came the

Conference

rejoinder from session chairman Lars-Olof Bjoerskaer of Industridata in Sweden.

Dorn then added "I am only half serious when I say that. The problem has not arisen in the United States with the exception of maybe one or two extremely minor and essentially trivial matters over the years.

"I am hoping desperately to keep the problem penned up on the other side of the Atlantic. I would like to keep it in the UK, as a matter of fact, where it seems to be at its worst," he said.

"I think the root of the problem in the UK is that the unions are a lot smarter about this problem than the management."

Dorn pointed out that 90% of the documentation on the problem comes from the unions.

"They have done all the work. And the management? Well, they have gone off and had drinks or gone to tea or something. Amateur management and professional unionism – it's a mismatch," Dorn said.

All the conferences were available on cassette except Alvin Toffler's lunchtime talk. He would not give permission for general release. He's smart, that Toffler – if people were to go out and buy a cassette of his talk, what would they need to go out and buy 'The Third Wave' for? (That's his new book.)

The other two lunchtime talks were given by Art Buchwald, who turned out to be as humorous as expected, and by another lesser known but equally brilliant wit, Theodore Levitt, a professor at Harvard's graduate school of business administration.

Levitt: "This industry has had about three decades of ascending euphoria. The railroad business was once a fantastic growth industry. Thirty years later, they were flat on their fiscal chassis. The demand for services did not decline, but the railroads themselves went down. Now if you take the railroads' history, cross out the word railroad and you can put in electronics in the same places.

"This is what I did in a report to Texas Instruments," Levitt quipped.

As is usual at these conferences, there were announcements about products, takeovers, and so on. John Imlay, chairman of Management Science America (MSA) announced that his company would acquire the American and British business from a South African company, Q Pac, which is only just beginning to get over an unhappy period in its history here in Britain, over its payroll package.

And Intel announced, or rather – as is more customary in the semiconductor industry – started speculation about the imminent announcement of a special processor to handle data base work. IBM has been working on the concept of a back end database processor for some time now, and the two companies are known to be putting their heads together to benefit from each other's technologies.

James Tillinghast, Intel's database product specialist, hinted that the machine would take the form of a co processor similar to those used for mathematics and I/O for the 8086 16-bit superchip.

But the Congress was not all fun and no work. On the second evening, everyone had to get dressed informally and work hard at making out they were enjoying themselves at an organised outing at the Marine World amusement park outside San Francisco.

One could not help but get taken up with the yahoo of good clean American fun – well, most of the time that is. At one point an attendant had to rush on to the ring with a shovel to catch the droppings from an elephant who was just about to step over a showgirl. His plan foiled, the elephant then wet her leg as he stepped over her, to gleeful squeals of delight from the crowd.

Some Adapso chiefs also joined in the fun. Robert Weissman, Adapso's senior vice-president, took a ride on one of the elephants, while one gentleman from Adapso's Japanese equivalent took a kiss on the cheek from a killer whale. Peter Cunningham, another Adapso committee member, then took a ride on waterskis.

Next year, the congress moves to Copenhagen. I think I will stay home and do something sane. Like skyjumping. ■

Boris Sedacca is the features editor of the weekly Computing

Theodore Levitt: This industry has had about three decades of ascending euphoria

John Imlay: Q Pac has lacked [illegible] support

Bob Weissman: Took a ride on an elephant

I appreciate the time and money my company could save using a word processing system.

In fact, I've already invested a lot of time in planning where such a system would benefit our organisation.

But it seemed to me that in order to make a rational decision to purchase exactly the right system, I would need even more time.

The next, vital step

I should need to see salesmen, plough through reports and technical data, visit showrooms. Even badger my business friends for their word processing experiences.

Then a colleague happened to mention the Which Computer? Show. But, as I explained, we already have a computer – word processing was our next vital step.

Computer and word processing forum

He soon put me in the picture. Word processing was an important part of the philosophy of the Which Computer? Show.

Under one roof there would be manufacturers, consultancies, bureaux, leasing companies.

From November 25-28, Hall 7 of the NEC in Birmingham would be a computer *and* word processing forum for everyone involved in business.

So now the two of us are committed to attending on at least one of the four days. We shall compare, consider and investigate.

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C[illegible] [illegible] racing [illegible] about the [illegible] [illegible] Saturday in [illegible]

T[illegible] today's [illegible] development and [illegible] electronic [illegible] processor has helped [illegible] the production of these games

When we look at the current state of the art in electronic games we can see that there are several distinct types of games The origins of some date back to early mechanical and electro mechanical offerings particularly in the field of public amusement games such as fruit machines and the now legendary Space Invaders and its variants However those offered for personal use in the home owe their existence entirely to the advent of micro processor technology and therefore the means to make high volume low cost products with a high intelligence factor

Darwin with his evolutionary theories would have found in the games industry another one of the Galapagos Islands as we shall see later

We have read much lately on the primary aspects of video games and how many manufacturers copy each other's products But the law of the jungle really does apply in this field and always has done Only a few years ago the largest volume of public entertainment games sold were fruit machines these were usually based on relay technology and wired logic Fortunately for the manufacturers some of the more esoteric developments or 'features' were eminently patentable A notable development in this field was the nudge feature However when one manufacturer introduced this feature, the rest were forced to follow or go out of business The fickle punter quickly tires of a feature or machine and switches his allegiance to another In those days the poor manufacturer was faced with enormous difficulties in trying to maintain a larger customer base and yet continuously introduce new games and re-vamp old ones to keep his head above water! But these pressures have also bred into the survivors a fantastically high level of ingenuity and inventiveness Other industries could well learn some lessons from the way that games manufacturers invest in new products almost daily and yet still make handsome profits There is nothing terribly new about piracy therefore In this industry and in the past it has generally evened out without too much loss to any one contender It is a basic fact of life in the industry

The mini TV game (Tennis, Practice, Football and Squash) by Ingersoll plugs into a home TV aerial socket (for AC/DC operation an Ingersoll XK9 power pack retailing at about £4.50 is required) and includes an instruction manual are included in the box

THE GAMES RACE

While we are on the topic of fruit machines it is interesting to look at today's marvellous monsters of micro processor technology Daily we read about ingenious little gismos being introduced to all sorts of fields as new 'micro-based' whatsits but no one has sung the praises of the micro-based fruit machine Though it has largely been overshadowed by the new video games, it was and still is an object lesson in low cost and well-engineered process control There are a variety of micro controllers in use today but they can be regarded as similar for the sake of this discussion

As I have already stated the traditional fruit machine was based on relays In fact a typical fruit machine had perhaps 60 relays three or four sequences and a mass of wiring producing a 'brain' of about a cubic foot in size Ingenious use of asynchronous sequencers and cams produced the variances of spin delays and 'hold' availability etc to generate a reasonable approximation to a random game

With this mass of hard wired inflexible and relatively unreliable logic the fruit machine became an early and an ideal prey for microprocessor substitution Some developments were performed in house by the manufacturers and others by contracted micro processor consultants A variety of controllers emerged based on all sorts of microprocessors including TI 990, M6800 and the ubiquitous Intel 8080 However life was not all roses for those involved in these developments Production costs by the various competitors varied by one or two orders of magnitude with one manufacturer reputedly spending six figure sums to achieve the same ▶

Galaxy Invader ... the hand held version of the now familiar Space Invader coin-operated game The game is marketed in the UK by Computer Games Limited of Barking Essex

The Wine Bar Astronauts

Gary Beckwith owns *Gordon Bennetts* a wine bar near the Old Vic Theatre London He installed two electronics games machines — Space Invaders and Space Chaser Space Invaders is the more popular, and also the less difficult, of the two More men than women play According to Gary the games are good value during an evening out because the excitement they generate lasts longer than the time taken to play them The average game lasts five minutes and the average amount spent is sixty pence for three games

Gary says I think the games are brilliant — but then they're good earners A player always tries to beat his or her last best score So the target is never fixed always gets slightly further away and that's a great incentive Any comments made during a game usually form a choice collection of swear words

His customers have recently begun asking for the type of game (Galaxian) mentioned by Paul Shimell in this article People seem to like playing at space pilot and navigator disappearing into hyperspace only to pop up in another part of the Universe ends as another did for less than £10 000

In the end the successful controllers were more or less organised as a single board computer sporting as many as 80 channels and anything from 3 to 10k bytes of software One fairly typical controller had an Intel 8080 with three EPROMs (2708) to provide the relevant game program, and three PIO controllers giving 72 channels of independent control These Single Board Controllers usually sported the complete voltage regulation circuitry required to drive everything from 12v DC lamps to 50v AC solenoids Surprisingly some of these controllers can be bought for as little as £100 complete with games programs, a far cry from the sort of costs usually associated with single board computers from some of the semiconductor manufacturers

Given this new base of flexible control the scene would have been set for a nice stable phase of operation for the amusement trade, where new games could be achieved by little more than a faceplate change and new program But just as things got under way the video game revolution took hold

Space Invaders

The now famous Space Invaders originally from the Taito stable really caught the minds and hearts of the amusement arcade and pub punter in 1979 and generated lots of interest in the media However it was not an invention out of the blue but a rather clever adaptation of an older game

In the beginning as it were there were bat and paddle games like ping pong and many variants on this theme For a while these games had a good run good enough for some purpose built chips to be developed that allowed the games to be introduced for home use It was usual to play these games against an opponent but one player variants were also popular

The public amusement trade really thrives on one man games and so new developments of the one man paddle games were soon on the scene Breakout was a highly successful development of the paddle games, creating a multi-layer wall which would be steadily eroded using skill to achieve a higher points score

For a while Breakout and Super Breakout and other variations reigned supreme Six months later almost a standard in the industry the Invaders arrived This was a brilliantly conceived game but really only introduced two new factors The brick wall was now a wall of invading monsters with the added factor that it moved! The second new factor was that the missile replaced the bouncing ball and the little blighters fought back! The play appeal of this game was so high that it has torn apart the market in the past twelve months but it too has now been surpassed by the new Galaxian game We will come back to 'play appeal in a moment With Galaxian and others like it the principles are the same as the last generation with some clever background colour graphics and general use of colour in the effects but the invaders don't advance in regular formation but peel off and attack in a very determined and uncannily intelligent manner The next developments in this particular evolutionary line are already well under way

Another video game family is that found mainly in amusement arcades and based on car driving skills It is in fact a direct descendant of those old mechanical mazes on a table where one has to steer a large ball-bearing through an intricate route

All this competition piracy and possibilities of quick fortunes to be made is the nectar of the amusement game manufacturer but is dreadful for the poor electronics engineers engaged to develop such games The games evolution has almost outstripped the capacity of the electronics revolution In some areas the technology has been pushed very far indeed

Since the fruit machine controller of two years ago which probably sported a dozen integrated circuits the latest video games controllers have single-board computers sporting some 120 ICs (integrated circuits) utilising the latest available high density memories and other LSI (Large Scale Integration) devices There is so much going on on the screens that it is impossible for a little eight-bit micro to keep up much of the display is created from specially developed circuits using traditional TTL technology What has changed little is the price and these massive arrays of electronics are still being produced for a couple of hundred pounds a time

There are other problems associated with producing coin in the-slot games other than straight competition regarding the play appeal' of such games These are the commercial pressures regarding the siting of games The manufacturers and operators face a dilemma — the game must be attractive but at the end of the day it must make money Therefore with a video game the major problem is to make the game sufficiently attractive for even the most incapacitated or inebriated punter to have a go and have some fun but sufficiently difficult to dissuade the skilful player from hogging the machine for an hour or more One (legendary?) player enjoyed an Invaders game for twelve hours on a single coin

The manufacturers resort to some cunning methods to make the games more difficult The latest variants of the Space games have buttons instead of joysticks to move the gun platform etc , left or right This is more difficult to co-ordinate It is also no accident that the movement buttons are placed at the left hand whereas most people would prefer them on the right!

The Raceway computer roadracing game challenges players to drive the racetrack avoiding collisions with l e d lighted cars The player who completes four laps within the 99 second time period wins and earns an electronic trumpet of victory From Tiger Electronic Toys Mundelein Illinois

A subtle feature of the Invaders game was its excellent use of sound A steadily increasing heartbeat-like throbbing sound raises the adrenalin level and also forces the pace of the punter actually pacing the punter to a point where he or she will make a forced error! To play the game with no sound is easier but far less exciting

This dilemma of play appeal ' versus fast cash was really apparent in the development of fruit machines for bingo halls The Bingo Hall Syndrome went like this during the intermission in the playing of Bingo the participants line up at rows of fruit machines to find further ways of losing their money The machines are only running for short bursts and therefore all the design skills went into producing special fruit machines that held interest in one machine rather than its next door neighbour but didn t let a game last for longer than four seconds Here the microprocessor really came into its element It was possible to place two machines to all intents and purposes identical in the same environment and tune the characteristics until an optimum was achieved using standard statistical sampling techniques with the second machine acting as a control

So where is it all going to end? The answer is that it isn t! We can look forward to men and machines locked in mortal combat for years to come

A last word on piracy With the Japanese complaining of competition and plagiarism, what was that saying about pots and kettles? ■

●Paul F Shimeld is Technical Director Micro Scope Ltd a company formed in July 1979, that specialises in microprocessor application projects in industry and commerce He has been in the industry since 1969 and has worked on projects for some of the major computer companies

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S. Kestner

Discrete Structures of Computer Science
by Leon S Levy published Wiley price £10 00

During the last few years Computer Science has developed from being a collection of different topics borrowed from other subject areas to being a single overall unity Most of the early academics in computing were former applied mathematicians scientists engineers and perhaps some economists Their concern was numerical analysis how to get accurate though approximate answers and how to squeeze more results from a computer that was small and slow Meanwhile the commercial programmers went their own sweet way relying on common sense and experience Each group disdained the other and pure mathematicians ignored them both

This immaturity began to be outgrown during the late 60's Commercial programmers found that their systems were getting too large and complex for even the most hard headed to control the recurrent notorious failures could not be written off as due to poor management and inadequately skilled staff Some academics became interested in the problem of how to demonstrate that programs were correct — and discovered that some of the constructs that could be used in programming languages were very much more difficult to reason about than others Computers began to be used for more varied kinds of problems requiring the use of various kinds of complex linked tree network data structures

The result was everything that now goes broadly under the name structured programming Several methodologies for designing developing and testing large programs were published the topics of academic papers began to change commercial courses were set up and computing staff sent on them

The result was also to make the job of teachers and students of computing much more difficult A new set of skills was needed but there were no text books to teach them Conscientious and knowledgable teachers spent hours digesting the new topics and developing their lectures and teaching materials Others didn't The result was also a great opportunity for text book writers

Discrete Structures of Computer Science by Leon S Levy (Wiley) is an attempt to supply this want The author is clearly a pure mathematician who has seen that many of the difficulties that programmers have are trivial from an algebraic or set-theory viewpoint His book is intended to put them right Chapter 1 is about the basics what in Britain would be called New Maths It starts with sets relations and functions and manages to cover a lot of ground achieving matrices Boolean algebra and finally Karnaugh maps It starts entirely from first principles defining a set and each later definition is rigorous in terms of the previous ones It has examples of each definition a clear summary at the beginning of the chapter a review at the end and varied exercises The writing style is straightforward and lucid and the text is well set out on the page, so that it is pleasant to look at But I think the whole enterprise is misconceived Anybody who has not met the idea of a set before may be able to understand what follows as a logical entity but will not be able to make sense of it On the other hand someone who has met it will find the explanation too lengthy What is missing is the motivation To a non mathematician the difficulty with sets is not just in understanding what they are but in seeing why a particular definition is interesting Similarly at each further level there is too little for the novice, too much for the initiate

As the book begins so it goes on. Chapter 2 deals with directed graphs ways of representing them as matrices and things that can be done with them leading to finite state machines Chapter 3 deals with groups algebraic systems homomorphisms and congruences and again links the ideas to finite-state machines Chapter 4 deals with context free grammars, recursive definitions (including various definitions of effective computability including structured flow charts Turing machines a bit of predicate logic and the unsolvability of the halting problem

All in 50 pages! The final two chapters include two automata and a formal correctness proof of a (simple) compiler

In the preface the author says that the book is developed from notes used for a second year undergraduate computer science course at the (American) University of Delaware I could not expect my average second year computing student to find it of much use The ideal reader seems to me to be a final year Pure Maths undergraduate (or perhaps postgraduate) with a smattering of programming knowledge Computing teachers might find it useful if it were treated as a long syllabus rather than a text book

At the end of the book the author claims that the student is now ready to read the technical literature in the subject. Unfortunately no bibliography follows there are only a very few references scattered in the text I feel that this claim is true but only because those not already able to read the literature will have struggled that far

To sum up the book does not address the problems of computing practitioners It is not suitable as a course text Perhaps one copy should be bought by a university library for those who wish to dip into it

Simon Kestner is at the
Mathematics & Computer Department Polytechnic of the South Bank London ■

EDITOR'S CHOICE

Computerisation For The Small Business
by Edward G Cluff
Published (1979) by Input Two-nine Ltd 7 Banstead Road Purley Surrey CR2 3ER. Paperback £3 50

The author is the Secretary-General of the Institute of Data Processing Management (IDPM) The book gives good practical advice to the intending first-time computer user Ted Cluff is clearly writing for the "bigger" small business and this bias is strong and in the open — hardly surprisingly he is on the side of the data processing department Good buy

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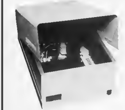

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Patricia A. Paterson

*Oaklands R C Comprehensive s efforts to get its own computer would bring a smile to the face of Samuel Smiles**

SWITCHING TO A SMALLER COMPUTER

In October 1979 we decided to buy our own computer not a very momentous decision, for many schools have *built* their own computers not even a very difficult decision, since there is so much emphasis at the moment on the 'silicon chip', and schools are being encouraged to develop courses in the new technology of the Eighties But it has proved to be a decision difficult to implement and fraught with problems

To begin at the beginning Computer Studies, in various forms has been taught at Oaklands School since 1974 The first courses were as part of a C S E Mode 3 Examination in 'Mathematics and Computer Studies Subsequent changes in staff, syllabus and demand from pupils have led to the development of an O level course in Computer Studies offered as a two-year option in the Fourth Year Constraints on both finance and staffing levels have meant that, since the course is now 'O' level only, many pupils are unable to study the subject, either because they wish to take other subjects timetabled at the same time, or because they do not have the level of ability to cope with the demands of an O level syllabus

We therefore decided to reconsider the position of Computer Education in our school, and the desirability of encouraging some degree of 'Computer Awareness' in every pupil became more and more evident We decided that what we needed was a broad-based non-examination course that would help to present the computer in a friendlier light. To give the course any real meaning, and to interest and hold the attention of the less able children, as well as the bright ones it became more and more obvious that we needed real hands on experience, instead of lots of paperwork

During the past seven years the practical content of our courses has been solely by means of batch processing at various Computing Centres At one time when the post was cheaper and more reliable pre-punched cards were sent to Imperial College London to be processed As the need for more immediate resources developed, we transferred allegiance to Winchester where various facilities were made available on the Hampshire County Council computer This worked very well for a while – programs were written on coding sheets and duly posted to Winchester Within four days, if we were lucky, print-outs were back at school Of course, a mis-placed comma or a wrongly crossed 0 (for Winchester, we crossed the letter not the figure) meant another week whilst corrections were made, but with care and determination reasonable results were obtained

Unfortunately the word spread! More and more schools discovered the excellent service, until eventually the Computing Department was forced to send work out for punching and obviously this led to a gradual lengthening of turn-round time Finally a halt had to be called However we were very lucky — schools in our area were advised to transfer to Portsmouth Polytechnic Computer Centre where similar facilities were made available, with the added bonus of a twice-weekly collection and delivery service, which was worked in with other administrative transport So now, our coding sheets with their mis-placed commas and wrongly crossed 0s (Portsmouth cross the number, not the letter) go off twice a week to be punched and printed

Portsmouth Polytechnic also offers the opportunity to take parties of students to look around their Computing room and to use the terminals of their Computing Centre The interest stimulated amongst our pupils by one short experience of interactive computing made us realise just how beneficial our own computer could be There is another alternative – that of a remote terminal linked in to the Portsmouth Polytechnic computer But the difficulties with this include the cost of the terminal, the need for a G P O landline (long waiting list) the limited time that would be available on a terminal, since so many other schools also use this facility, the annual telephone running costs, and also the fact there there is no spare terminal port at the moment!

So some form of computing equipment on site at school became attractive Having decided to buy a computer we now had to consider the various makes and models on the market Leaving aside for the moment (but not for long) the thorny problem of finance we spent considerable time looking for practical information on what to buy Conclusion – there is very little unbiased yet useful, information available

Everyone has his own personal preference be it for PET APPLE TANDY ACORN or what have you (I m sorry if I ve cussed out your favourite!) Is it that, having spent several hundreds of pounds one feels a certain brand loyalty or is it that one is unwilling to admit to making an expensively wrong decision? (I hope I shall shortly be finding out, and I suspect that the latter is the case!) Apart from reading copious advertising literature we have talked to other teachers in the area and a distinct bias towards the Commodore PET has emerged partly because theoretically at least one can exchange interesting programs with other PET users (and there are more of these than anything else at the moment in our area), and partly because of a desire of the Local Authority to facilitate servicing and maintainance of equipment Also, one must admit the PET does seem to be the most child proof and best-value machine around! (We did manage to borrow a PET for two weeks and this helped us to make up our minds) Looking at available peripherals also biased us towards the PET and recent articles in several computing journals seem to support this decision – I hope we are right

Further discussions with staff at school led to the outline of the system we should like to buy Careful shopping around has led to the discovery that a 32K PET can be bought for the same price as a 16K version – and both models have facilities for a floppy disc system too So a 32K PET + printer + disc system – just under £2,000!

---

*The 19th century author of **Self Help**

One may question the need for such an extensive system, but if the school administration is hoping to use it for option grouping, storing records, examination entries etc., then the extra capacity is necessary.

Two thousand pounds – even if you say it quickly, it's still rather a lot of money to find when Education budgets have been cut to the bone and there is no spare cash in School Allocation. A further complication for us is that the school's aged minibus needs replacing and there is already a minibus fund in operation. So we decided to put aside, for the moment, all thoughts of expensive peripherals and to concentrate on just the microcomputer – around £700.

Possible sources of money for school projects fall into two distinct groups –

1. connected with school – i.e. pupils, parents, Local Authority, etc.
2. not connected with school – i.e. anyone else.

School-based fund-raising

It is important to realise that most money raised IN school will be in sums of less than 10p, coaxed and cajoled from pupils. Most children nowadays have an eye for a bargain and are not readily parted from their money, so we had to be inventive. To begin with, we raffled Scientific Calculators. Tickets were 5p each, but the bait was the promise that if a strip of five tickets was bought, the buyer would be able to play on a PET during the lunch-hour. We were fortunate enough to find a supplier willing to lend us a PET for a few days, and thus were able to honour this pledge! We made a profit of over £57 before we had to return the computer. This line has been followed up with T.V. games during the lunch-hour, but at 1p per person per game, proceeds are naturally much lower. We have raffled bottles of wine amongst the Staff (average profit of £6.50 per bottle) and at Parents' Evenings have raffled prizes donated by various firms outside school (see below). The collection and sale of used postage stamps has raised £50, and other projects in hand include a Jumble Sale, Cake Sales, Ice Cream Sales, competitions etc., too numerous to mention. We have also appealed directly to parents for support and have written pleadingly to the Local Authority for help in the next financial year.

Computer Tournament

Tastier beer is one of the possible benefits of the microcomputer revolution, according to research undertaken by South Yorkshire schoolchildren taking part in the annual computer tournament run by GMS Computing Limited of Sheffield.

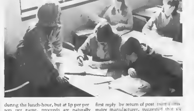
Other microcomputer applications that the schoolchildren researched included printing quality control, automated freight movement, indoor environmental control, greenhouse automation, steel reheating furnace control, and postal sorting.

The presentation of original applications studies formed the qualifying round in this year's GMS tournament, the final of which took place on July 23. The four teams to have won through to the final come from City School (Sheffield), Swinton School (near Rotherham), King Edward VII School (Sheffield) and Kirk Balk School (near Barnsley).

The qualifying round entry from City School was one of the most imaginative. It detailed how a microcomputer system could constantly monitor (and to some extent automatically adjust) the temperature, specific gravity, colour, pH value, and other critical factors in the brewing process. This would ensure perfect quality control, prevent wastage, and create better tasting beer.

In the final round of the tournament competitors will take part in a computer business game held at the GMS computer centre in Sheffield. A microcomputer will be donated by the company to the winning school, who will also be presented with the specially commissioned GMS computer trophy.

Schools



Fund-raising outside school

Our approach to people not connected directly with our school has been by means of letters of appeal. Our first target was firms connected with the TRIDENT scheme in which our school participates. This is a scheme, pioneered by Hampshire, whereby pupils in their final year of school experience the 'Work-environment' for three weeks. One objective is to foster positive links between Schools and Industry. Sixty five letters were sent at the beginning of January – the response was as follows:

Donations of money	7
Donations of raffle prizes	3
Refusals	4
No reply	51

Of the seven donations of money, two were private – i.e. the manager regretted that his firm could not help, but he sent a private donation himself! The overall response has been a little disheartening, but the few letters of support which we did receive were very encouraging in the views they expressed.

Ever hopeful, we prepared a second letter, this time to go to local or national firms connected in any way with computing, to various local and national publications, especially those which are computer-orientated, any firms with whom the school has dealings, and anyone else who is recommended to us! Our first reply, by return of post from a computer manufacturer, suggested that we should concentrate on teaching the present curriculum and not include courses on particular vocational subjects. (Their choice of words, not mine.)

We still must face the problem that one machine will not allow the pupils to have much personal contact with a computer, but they will be able to see immediate results of their investigations, which we consider important, instead of waiting for days. We plan to use the Schools Council Project 'Computers in the Curriculum' in several departments, and to develop our own Course in Computer Awareness. Examination classes will still have need of external facilities for project work, but they will be able to learn the rudiments of programming with much less delay and frustration, even if they do have to give up their lunch-hours to run their programs. We don't anticipate too much resistance in that area. New small machines are currently being evaluated – maybe we should be thinking next in terms of several, small units instead of one large system? Who knows where educational computing and educational computers will go next? But wherever it is, we shall be there, trying to find the money to keep in touch! ■

•*Oaklands R.C. Comprehensive School, Waterlooville, Hampshire*

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Computer Assisted Learning **The Open University** **Tom Vincent**

SOME APPLICATIONS OF A MICROCOMPUTER

The Open University is very conscious of the uses of microcomputers especially in view of the unique place it occupies in the country's educational system

The Open University is very dependent on the use of computers to support teaching at a distance to students who currently number 60 000 There are two major aspects of this support

(i) *Data Processing* — information is held on file for each student to facilitate basic operations such as the mailing of course related material including home experiment kits the allocation of courses and the generation of course results at the end of each year In addition the data-base is accessed by terminals located in 13 Regional Offices in order to establish and maintain links with over 6000 part time members of staff

(ii) *Student Computing Service* — three computer centres (London Newcastle and Milton Keynes) are linked to computer terminals (teletypes) in many of the 260 Study Centres located throughout the U K During the course of the year up to 30 000 students are required or advised to make use of this computer facility for a variety of activities which include programming data handling simulation and tutorials In addition computer facilities are provided at Summer Schools during July and August

Microcomputers

Until 1979 all software for the Student Computing Service was developed on centralised mainframe computers However with the increasing availability and decreasing cost of microcomputers more and more software is being developed for these devices The first objective has been to provide this facility at a number of Summer Schools where in particular the VDU output and graphics capability can be exploited

Research projects

There is a wide range of research activity within the Open University that is focused on the use of microcomputers this is clearly reflected by the current interests of the Computer Assisted Learning Research Group which plays an active coordinating role within the University

This article describes some research that has been taking place over the last 12 months into potential uses of a 32K Tandy TRS-80 microcomputer This activity is located in the North West Region of the Open University where there is a general interest in the application of low-cost/limited configuration systems[1] The particular areas of interest that have been developed are

- The use of low cost computing facilities in a laboratory environment
- education administration

Laboratory environment

The first project is not uniquely directed at the needs of Open University students it can be considered relevant to the teaching of chemistry at undergraduate level in any institution

In fact the project commenced in 1972 at Liverpool Polytechnic where a PDP8/E minicomputer was located in a Physical Chemistry laboratory Three teletype terminals 12K core store Edusystem — 20 time sharing and paper tape library formed the complete system which by any standards was a limited configuration however its use increased to 100 hours of terminal use per year for over 300 students[2]

Since 1979 a similar software library has been developed on a TRS 80 microcomputer with programs having been rewritten to take advantage of the VDU output Without exception the programs have been considerably enhanced by this transformation even though the TRS 80 has only low resolution graphics The following two examples are taken from the current software library

Reaction kinetics

One of the limitations of using a teletype for a system used by science students is the lack of the facility to repeatedly and quickly produce graphs that illustrate the relationship of one physical quantity to another This is particularly true of reaction kinetics where there is a need to study the concentration changes of reacting species over different periods of time as initial reaction conditions are changed Figure 1 shows a consecutive reaction with A as the initial species B the intermediate and C the final product

The effect of low resolution is clearly

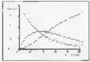


Fig 1

shown by the discontinuities in all three curves. However, the development of a maximum concentration in the intermediate B can be seen — an important feature for a student. At this stage a second graph could be generated which would give more detail over the range 90 — 150 seconds (in this case) in order to find the time of maximum concentration. In practice the graph is developed on the screen slowly (approximately 60 seconds) with the defining letters A, B and C leading the way from zero time onwards. Experience has shown the advantage of this technique over an 'instant' presentation in that it allows time for a student to observe the concentration changes taking place which are inherently time-related. Other types of reaction can be followed in this way — up to 5 reacting species can be reasonably accommodated on the same graph.

pH titration simulation

All the programs developed for a laboratory environment have been included as an essential *part* of the respective experiments. In practice, this means that a student working at the laboratory bench will make use of the computer at an appropriate time as would be the case with other equipment. This is particularly true of a 3-part experiment associated with a pH titration. One of the objectives is to re-inforce the theoretical aspect of the laboratory experiment, a traditional deficiency in chemistry where there can be a preoccupation with the mechanics of the practical work during long periods in a laboratory.

In the pH titration experiment, a student would first make up an acid solution and then measure its pH. An exercise is then set which involves calculating the theoretical pH of an acid solution with the same concentration. This involves handling relatively complex equations such as

$$[H^+]^3 + [H^+]^2 K_a - [H^+](K_a[HA]_0 + K_w) - K_w K_a = 0$$

In order to solve the equation, the student is introduced to iterative techniques which can be readily handled by the micro-computer. With a suitable screen presentation of the convergence associated with the iterations, the problem of demanding mathematics can be transformed into an interesting experience. In this way the concept of pH is not lost in a mass of laborious calculations.

Having completed the simple acid solution experiment, the student progresses to an acid/base titration. This is not a difficult experiment in terms of the practical component, however it does provide a more demanding insight into the theoretical aspects of the changes taking place in the solution during the course of the titration.

Iterative techniques are again employed with equations that are more complex than that shown previously. At one stage the output appears as in Figure 2 where, in this case, 12 points are being calculated. An observant student would notice that the length of time taken to calculate each point varies systematically (shown by rate of change of the second number).

The Open University

Fig. 2

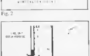


Fig 3

A later table re-inforces this observation with a quantitative summary of the number of cycles per iteration. This in turn leads to interesting discussions as to why it occurs.

With the question posed, the computer takes a little time off to show the simulation on the screen (figure 3).

The burette empties incrementally as the tap is shown to open and close and the beaker gradually fills. After each increment the pH is calculated and plotted on the graph. The sharp change in pH at the 'end-point' of the titration is clearly shown, confirming to the student that appropriate parameters were input to the simulation.

Education administration

As previously indicated, the Open University is very dependent on computer systems to provide administrative support for its large student population. The Data Processing facilities are very sophisticated but do not, and could not without considerable expenditure, provide the flexibility and access to data in the way that meets the needs of every central and regional member of staff.

In this context, the role of the microcomputer is being considered in the second of the research projects in its potential for providing education *administrative* support to meet local and regional needs. The following examples illustrate two applications of the TRS 80 microcomputer.

Conditional registration

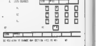
Each year, over 60 000 students register for courses in the following year as continuing students; allocation to courses is made after examination results are known and, where possible, preferences are met within the criteria of maximum course numbers. The process of conditional registration involves each student completing a form on which preferences are indicated with respect to future course choice. In addition, account has to be taken of the results from current courses.

There is no doubt that many students find the form difficult to complete as the implications of the various combinations of answers are not always apparent. In this context, a computer program has been developed which presents the form on the screen (figure 4) and uses the lower part of the screen for the presentation of questions and input of answers.

If answers are acceptable (available course, credit requirements, etc.) then they are entered into the appropriate boxes. If not, then a message of explanation is output.

One advantage of this arrangement over a conventional form is that questions can be modified in order to take account of previous answers. For example, the questions relevant to boxes A1, A2 and A3 can be referenced to S101 and M101 (in this example) rather than the general style of question that appears on the actual form.

When all of the questions have been answered, the screen is cleared and the implications of the answers are then displayed. If this does not meet the requirements of the student, then the form can be re-called and the appropriate section modified. In the current version of this program, the final stage is to output the screen memory map to the line printer for a hard-copy version of the final completed form.



DO YOU WISH TO CHANGE ANY SECTION (YES OR NO)   NO

Fig 4

This method of completing the conditional registration form has only been used experimentally to date, however, other computer based developments in the Open University could be enhanced to include this interactive form completion with the data finally being directly transmitted via telephone lines to a *central computer*. This would also overcome other problems associated with the present method that uses the postal service combined with manual batch entry to the mainframe computer.

Disabled students

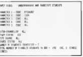
Study with the Open University has been found to be appropriate for many disabled students who would not otherwise be able to follow a degree course. Currently there are more than 2000 students who are disabled. Identification is important as this, in turn, leads to directing support to these students through a variety of means which include tactile diagrams, radio and TV transcripts and course material on audio tapes.

To assist in providing this support, a 5-character code is generated for each sutdent based on his or her particular disability and requirements with respect to general study, study centre attendance, summer school and examinations This coding is then included as part of a student s basic record

Until 1979, it was not possible through Data Processing facilities available in the regions to use the coding in terms of identifying groups of students with the same disability or who had needs in common Hence for example it was not possible to identify at a terminal all hearing-impaired students when a relevant conference was arranged or all blind students following a particular course

At that time, it was decided to develop a search program on the TRS-80 using a data-base which included all disabled students in the North West Region The total number of disabled students involved was 158 and, with a *limited* record entry it was feasible to store this information within the computer program using DATA statements

Figure 5 shows a typical screen entry for the search program



```
INPUT TERMS     UNDERGRADUATE AND ASSOCIATE STUDENTS

CHARACTER 1 — CODE  [illegible]
CHARACTER 2   CODE  1104
CHARACTER 3   CODE  ALL
CHARACTER 4   CODE  ALL
CHARACTER 5   CODE  ALL

TUTOR-COUNSELLOR  ALL
STUDY CENTRE  168
1978 COURSE  ALL
COURSE STATUS  ALL
NUMBER OF STUDENTS IDENTIFIED = 7
TOTAL NUMBER OF DISABLED STUDENTS IN 300 = 158  INC. 5 SINGLE
 CODES)
```

Fig 5

The codes for the first character relate to disabilities that are associated with mobility problems, the second character refers to difficulties in attending Study Centres no search is required by the remaining characters

Further relationships are shown, and in this case, a particular Study Centre (168) has been chosen A search of the data-base then shows that there are 7 students who are allocated to the Manchester Study Centre and who have reported mobility problems in relation to attending that centre A second screen then gives information about each of the students identified

The only problem encountered using the TRS 80 microcomputer for this function was the maintenance of the data-base where individual student information changed during the year During 1980 a similar facility has been made available on the Data Processing terminals which has eliminated the need for further development on the microcomputer however it did clearly show how specific local needs could be met and indicated a possible route for future developments where data-bases are maintained on a central computer and then transmitted as required to *satellite* computers for local use

Future developments

As with many other institutions and organisations the role of the microcomputer has not yet been clearly defined in the Open University in relation to mainframe computers and mini computers There is little doubt however, that the microcomputer will continue to be applied where a stand-alone, low-cost system is appropriate There is considerable interest in the Open University in microcomputers that cost less than £250 which could possibly meet the needs of some of the 30.000 students — where a home-based system was appropriate

Research into more specific applications continues For example, the TRS-80 described in this article has been interfaced to a voice synthesizer with the objective of producing software for use by blind students Early indications are that this need could be met at a relatively low cost – a common element in the project described in this article ■

●*Dr Thomas Vincent was from 1953-1956 a research chemist in industry, from 1966-1972 did research in crystallography at the Universities of Cambridge and Warwick; was senior lecturer (1972-1978) in Physical Chemistry at Liverpool Polytechnic and has been Senior Counsellor at the Open University since 1978*

1 The support of Savant Research Studios is acknowledged in providing the TRS 80 microcomputer

2 Computers and Education Volume 2 pp 49-69 1978

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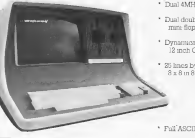

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Joe Telford

CAL at St. Patrick's

This article outlines the ways in which CAL has been used in one school. Its main purpose is to point out several successful avenues and blind alleys in the practical application of CAL.

Invidious as it may seem, schools tend to group children into three main groups:

Bright	(top 20%)
Less Able	(bottom 20%)
Average	(mid 60%)

These rough percentages are common to today's schools, though actual numbers will vary with region and school type. Another grouping of interest to those interested in CAL is:

Keen	(Self motivating 20%)
Uninterested	(disruptive or not motivated 10%)
Average	(Motivation varies with task 70%)

Again, variation of numbers occurs principally in the primary school where more pupils may be included in the keen group. The two groupings overlap but do not match completely, indeed sometimes the intelligence of pupils is at odds with their level of interest.

In our first steps toward CAL, we undertook examination of these groups and the structuring of programs to meet their different needs. We have isolated eight program types which are listed below in order of development. The list is not complete, but the categories are useful.

Type 1	**Practice/direct testing programs**
Type 2	**Learning via game playing**
Type 3	**Reward-after-task programs**
Type 4	**Demonstration/Simulation programs**
Type 5	**Information Retrieval programs**
Type 6	**Programs to 'teach' the computer**
Type 7	**Worksheet programs**
Type 8	**Involvement of extra peripherals (Not dealt with.)**

The subject of multiple choice questions is not in the list. We are very doubtful as to both their merits and the merits of more complex logical choice questions. Our problem is in providing *incorrect* answers (distractors) to include with the *correct* answers. These must be carefully designed and pretested. The number of questions is of importance, as is the number of answers to each question. Furthermore, multiple choice questions are most likely to make guessing easy, so careful marking is necessary.

Our first attempt at CAL, about two years ago, was quite predictably the standard Maths Drill – testing the four rules of number. Programs of this type, giving practice in one area of a subject, were classed as **Type 1** programs and are used across the curriculum. They teach by testing. Figure 1 explains the breakdown of this sort of program.

The level of difficulty for these programs can be set in two ways, depending on the subject matter of the program. In Mathematics programs involving numbers only in question and answer, eg

WHAT IS THE LOG OF 867.4?"

we may use either sequential or random numbers up to a limit. The math functions of the microcomputer interpreter solves the problem, and stores the answer for

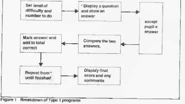

Set level of difficulty and number to do
* Display a question and store an answer
accept pupil's answer
Compare the two answers.
Mark answer and add to total correct
Repeat from * until finished
Display final score and any comments

Figure 1 Breakdown of Type 1 programs

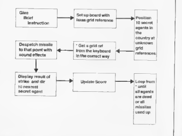

Give Brief Instruction
Set up board with base grid reference
Position 10 secret agents in the country at unknown grid references.
* Get a grid ref from the keyboard in the correct way
Despatch missile to that point with sound effects
Display result of strike and dir to nearest secret agent
Update Score
Loop from * until all agents are dead or all missiles used up

Figure 2 Breakdown of a game teaching Co-ordinates for Mapwork

Schools

later comparison and scoring. In subjects like Geography, History or Biology, where words or combinations of numbers and words are required, then data statements or data files may be used to hold question and answer together.

Once the sheer novelty of using a computer had worn off, I noticed that some pupils were making little headway. Indeed I had to deal with numerous interruptions to my work with full classes to deal with

"What do I do next Sir?"

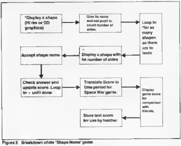

*Display a shape (Hi res or DD graphics)
Give its name and ask pupil to count number of sides.
Loop to *for as many shapes as there are to learn
+
Display a shape with the number of sides
Accept shape name
Check answer and update score. Loop to + until done
Translate Score to time period for Space War game
Display game score for comparison with friends.
Store test score for use by teacher

Figure 3 Breakdown of the 'Shape Name' game

Eventually a set of guidelines was developed for Type 1 programs, which has since been extended to include the other types with the objective of designing, for older pupils and novice teacher programmers, good programming practice for CAL

1. Instructions must be kept to a minimum, and must explain HOW to operate the program
2. Instructions for special key presses eg THEN PRESS RETURN must be included with the section where they are expected
3. Questions must be to the point and if possible answered on the same line as they are posed.
4. In the case of long questions or a large amount of screen information underlined or reversed text is desirable
5. The overall difficulty which the child experiences must come from the task *not* from handling the system
6. New topics or sections should dictate a clear screen
7. The overall language must be simple unless the aim is to teach new words. Incidental language must be understood by the least-able child to use the program

The guidelines above meant our old programs had to be altered to reach the new created standards. Most Maths programs needed further adjustment once fractions, decimals and the use of tables were introduced. The accuracy of the microcomputer to more than four places of decimals guaranteed that the children's four-figure answers would be continually wrong, so programs needed to be adjusted to accept, as correct, answers in a specified range of accuracy.

Very early in our attempts at Type 1 programs, we found that the weakest children enjoyed practice: the use of continual marking stimulated their interest. The brighter children generally used the programs of Type 1 less frequently. The wide mid-group began with well meaning interest, which deteriorated as the computer became less of a novelty. In all groups, keen individuals stood out. The behaviour of the middle range of children was of particular interest, since it was them we really needed to reach.

Our experience and difficulties suggested these further guidelines

8. Encourage the pupil after each question using his/her name
9. Explain any mistakes if this can be done simply
10. If at all possible, have power switches, mains leads, and RESET keys well out of reach. If software will allow, remove links to those functions which stop the program eg CNTRL C or STOP key

Throughout Primary and Secondary schools, the game of Hangman is popular. Similar games may motivate children to learn the computer away from or during lessons. The idea of these **Type 2** programs is that the child begins knowing little about a particular skill (eg using co-ordinates, iteration or spelling) and acquires skills through the game program. The teacher can then build upon the student's games experience. Figure 2 is a breakdown of a game which teaches co-ordinates for Geography and (with some adjustments) for Maths. The basic learning feat assisted by games is the acquisition of academic skills in a non academic way.

To our list of guidelines for CAL we add in the context of games:

11. Use whatever graphics are available when possible because they mean more than printed words to pupils
12. Sound is useful in programs to add realism and to focus the attention of pupils but, overdone, it forces loss of interest

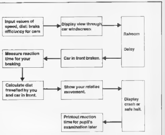

Input values of speed, dist, brake efficiency for cars
Display view through car windscreen
Random
Delay
Car in front brakes.
Measure reaction time for your braking
Calculate dist travelled by you and car in front.
Show your relative movement.
Display crash or safe halt.
Printout reaction time for pupil's examination later

Figure 4 Demonstration/Simulation of Reaction time

The output of games from a computing department in a comprehensive school is quite high However the academic merit of the majority of such games as Star Wars, Gunfight even Noughts and Crosses is quite low The tremendous interest which the middle band of pupils show in these games was in our case the major factor in the construction of programs of **Type 3** The game provided motivation, but we had to *harness* that motivation Thus was done in three simple stages – ●display some information ●test the acquisition of the learning ●and then play a non-educational game The children soon realise that high performance in the first two sections increases the length of the time they have to play the game The principle of rewarding work well done is not new Two of the more common programs of this type are the 'Magic Animals' program and the 'Shape Name' program both used in local primary schools Figure 3 analyses the Shape Name program

The important points about Type 3 CAL programs are

a) The child is shown the answers before any test is given
b) She is in competition with her friends only in her ability for example to shoot space craft thus protecting her from the cruelty of criticism of her intelligence
c) High scores in the game correspond to high scores in the test though a suitably designed game will allow the freak high score despite a poor test result

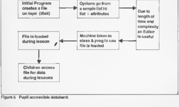
Type 3 programs are quite easy to mass produce using the same game, with different material preceding it in each case An extra guideline is needed

13 Competition is valuable if children can see how their friends are doing they will want to improve It is best to compare within the same general ability range otherwise poorer pupils become despondent

Demonstrations

Demonstrations are the **Type 4** of CAL program with which we have experimented Here the computer may be used in the full class situation controlled by the teacher Very early on however we discovered that a computer demonstrating an experiment or simulating say a steam engine completely automatically, was of little value to the pupils at secondary level for only the keen 20% really talked about it afterwards As a result guideline 14 was formulated.

14 Demonstrations should be *interactive* with user operations kept as simple as possible



Initial Program creates a file on tape (disk)
Options go from a simple list to list + attributes
Due to length of time and complexity an Editor is useful
Machine taken in class & prog to use file is loaded
File is loaded during lesson
Children access file for data during lessons

Figure 5 Pupil accessible databank

The basic interaction necessary for demonstration programs is the initialisation of values, eg speed distance brake efficiency as well as the occasional following of instructions Press any key when the brake lights come on Figure 4 is a breakdown of a driver simulation involving reaction time and brake efficiency

Other programs include a demonstration of the Doppler effect for fifth formers, where fire engines can be set off at various speeds towards and away from the observer, and a number of programs to demonstrate transmission of data in parallel and series via busses and modems for *CSE* computing classes

Demonstrations are more effective when a large monitor or TV is used This allows a pupil to sit at the normal monitor and perform the demonstration while the class follows on the large screen

The **Type 5** of program was initiated when it was suggested that it would be useful to have a databank of details on say animals metals or gasses so that during a lesson the computer would act as a dictionary containing information which may have been found in many different books or only in the pages of teachers notes But the computer must be easily portable simply because of the distance of the machine from the teaching room Figure 5 analyses this program type

As may be seen from the figure the amount of work going into the preparation of such a file is enormous Using 7K of user memory, files created will have several items missing for lack of space As useable memory rises so the complexity of the file may rise becoming useful at around 12K for a list of items, and at about 20K for a list plus attributes

Though accessing the file is still a problem, with the expansion of memory common words for queries can be used For example if a child wanted a list of all the metals which burned, he could type

LIST METALS

with the computer asking for the attributes needed

WHAT ELSE?
BURNING

The program then uses the first three letters of the input to display a list of items with these attributes though keeping the

MENUS *Versus*	KEY WORD COMMANDS
Avoid ambiguity	Increase the feeling of power over the machine
Need careful programming to avoid errors of layout	Need careful designing and error messages Must return to the correct program section after correction
No long lists to memorise	Some children will not read and understand the screen with a lot of words on it so keywords are easier
Long menus must be broken down taking up valuable space	The screen is remarkably clear at all times providing that error messages are self erasing
There is little chance of following the commands from start to answer on the screen	Question and answer can be easily displayed

language sample has several ambiguities

The Menu/Key word controversy has not been settled to my satisfaction yet Table 1 gives some comparisons between the two

The least used of the CAL programs in school at present is **Type 6** It is very taxing to write as alternatives play a very large part in its construction Fig 6 shows an example of one such program in its parts

Some suitable objects for such CAL include How to draw cross sections in Geography How to use a magnetic compass 'What is the correct sequence for using a lathe' and How do we solve simple equations/fractional multiplication/decimal division etc

Schools

These programs are of less use in primary schools and with the less able children of the secondary school because precise correctly spelled grammatical input is required Interaction is at a high level and review of the children s answers to date is often requested I have found that a large number of less able children can actually forget the question asked unless reviews are frequent Even the average child feels drained after working through such a program and when we use this type of CAL we usually provide a carrot in the form of a free choice of games afterward

The computer can also be used to aid learning in a wider sense by acting as a *resource* producing machine when access to a printer is possible I have classed such programs as **Type 7** Suitable programs can be used to print worksheets with answers, especially in Maths The use of a printer plus the school duplicator allows us to reach large numbers of children and reduce the workload of the teacher The printer also allows use of individualised work material to be taken away and used later in class or at home

Learning

From the work so far carried out at St Patrick s and the Cleveland Microcomputers Users Group (CMUG) two main conclusions have been reached The first is that children who are of lower ability find the initial use of the learning packages difficult This is because they treat every new experience as totally different to any preceding one The guidelines outlined ensure that, as near as is possible all programs are alike to use

Computer Aided Learning is far down the scale of useful teaching methods in most schools because it requires a great deal of preparation, reaches comparatively few children and has little documented evidence of value Wisely St Patrick s has attached computing to the mathematics department Here a separate room allows pupils to come and go with the minimum of red tape and without disturbing the maths lessons The computer supported by freedom of access the insatiable programming appetite of the computing classes and a growing number of successes with poor and average children both at the Pats and in local primary schools, is now a facility in demand by teachers with new entrants to their classes pupils who have lost time through absence less able classes in need of constant practice and it is now finding uses with full classes as a library function or demonstration aid

The present timetable for the use of the computer is shown in fig 7 In addition primary schools may borrow a computer for class use if there is no timetable clash or in the evenings for teacher use In association with the local User Group and a small firm, demonstrations at parents evenings have been given for schools in the county ■

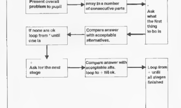

Present overall problem to pupil
Store answer in array in a number of consecutive parts
*
Ask what the first thing to bo is
Compare answer with acceptable alternatives.
If none are ok loop from * until one is
+
Ask for the next stage
Compare answer with acceptable alts. loop to + till ok.
Loop from + until all stages finished

Figure 6. Breakdown of teaching by feedback programs

	PERIOD 1	PERIOD 2	LUNCH	PERIOD 3	PERIOD 4	4 00-5.30 After school
Mon	OPEN FOR CAL		4th yr Social Programming	OPEN FOR CAL		Open to any clubs or interested pupils
Tues	OPEN FOR CAL		5th yr Social Programming	5th yr 'O' Level Computing		5th yr Programming Evening
Wed	OPEN FOR CAL		5th yr	OPEN FOR CAL		Open to any clubs or interested pupils
Thurs	OPEN FOR CAL		4th yr	4th yr 'O' Level Computing		4th yr Programming Evening
Fri	OPEN FOR CAL		5th yr	2nd yr Computer Appreciation		Open to interested pupils
Wk/end	Available for staff loan or use by selected pupils					

Figure 7 Computing Timetable, St Pats. Thornaby

●Joe Telford teaches Maths or Computing at St Patrick s Comprehensive Thornaby Cleveland and is Hon Sec of the Cleveland Microcomputers Users Group

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[illegible]

80 Character Card [illegible]
[illegible]

[illegible]

[illegible]

[illegible]

[illegible] M2 — [illegible]
[illegible]

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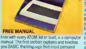

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Letter From America

Peter Krass

The merry go round From mainframe to mainframe database to personal computer to personal computer database

DIAL "D" FOR DATA

Data data and more data Without it personal computers are little more than expensive electronic toys With it in ample quality and quantity their limitations become largely those of the user s skill and imagination

For many personal computer users in the U S data and accompanying programs to put it all in is either too hard to get or, when it is available too expensive to enable them to get the most of their machines

Recently and in increasing numbers American microcomputer buffs are seeking an answer to this problem in the same place as their large mainframe counterparts have for many years — time shared databases Like large commercial databases these information libraries now enable personal computer users to access data gathered from a diverse group of sources be it the U S National Weather Service the Wall Street stock market or a major news wire service And unlike viewdata systems, which basically retrieve data and allow the user only limited interaction (such as ordering theatre tickets) personal computer databases offer the user the option of actually employing his machine s computing power to manipulate data, making use of all that information

While viewdata-type systems are becoming available in the U S many industry observers are not optimistic about their success here

' If you re wondering about the possibilities of something like Prestel Antiope or any of the other European systems you re probably looking in the wrong direction says Mark Plakias of New York research group Link adding ' What s going to go over here in the U S will be some sort of *hybrid* system with a lot more flexibility

According to Plakias the wave of the personal computing network future is going to be similar to the two information utilities available to micro users in the U S today They are the CompuServe Information Service (CIS) formerly known as MicroNet and the Source

CIS gives micro users equipped with the necessary software and access information (identification codes and the like) entry into the large database of CompuServe a $20 million-a year company that has been in the commercial timesharing business for a little over ten years CIS is less than one year old and is now technically owned along with CompuServe, by H&R Block Inc , a firm known for its income tax assistance service Today CIS has about 3 000 subscribers

Prior to June 1980 CompuServe handled its new CIS accounts through the mail But now the special software needed to use CIS is available exclusively at Radio Shack retail stores most of which also sell the popular Radio Shack TRS 80 line of personal computers

Radio Shack outlets will also soon sell what its parent company the Tandy Corporation calls the TRS 80 Videotex The Videotex terminal is an alphanumeric key board 4K of memory and a built-in modem Available in the U S beginning this October for about $400 the terminal hooks into the user s telephone and television set Thus equipped users of Videotex can access any number of databanks including CIS and the Source

The Source (a seemingly appropriate name isn t it?) is owned by the Telecomputing Corporation of America located in Alexandria, Virginia It offers its subscribers information from more than 2 000 programs The Source has attracted about 4 500 subscribers in its first year of operation

How do the two services compare in price and in number of services?

The Source will cost the subscriber $100 just to register On line time runs at $15 per hour or $ 25 per minute during prime weekday time (between 7 a m. and 6 p m) At all other times the hourly rate is $2 75 or about $ 05 per minute The minimum monthly rate is currently $5 00

The Source can be accessed on computers made by Apple Radio Shack Exidy Compucolor Heath Texas Instruments and Commodore In all cases some additional hardware such as modems and RS 232 interfaces, are needed

Subscribers to the Source can access data from United Press International the New York Times Consumer Data Base and major newspaper syndicates in addition to an electronic mail system application software packages, and travel and shopping services

Subscribing to CIS is much cheaper than joining the Source CIS customers pay a one time application fee of $9 00 part of which the company says is refunded in the form of one free hour of connect time Otherwise the basic rate is $5 per hour

CIS can be accessed via local telephone service in about 200 U S cities between 5 a m and 6 p m on week-days and all day on weekends and holidays

Subscribers to CIS do not really need a computer to use the network A dumb terminal with a communications interface and a telephone will do nicely although if you only have a terminal you can t really do anything with the data except look at it

CIS subscribers can access data on stocks bonds and options, computer games such as Lunar Lander and Space War, text editors, word processing and a software distribution system, to name a few

Additionally CIS offers an electronic mail and bulletin board system, whereby messages can be transmitted or left for other subscribers to the network

Although the two systems are technologically sophisticated and attracting many subscribers there is much evidence that they are only the tip of an iceberg of unpredictable size

' For one thing says Kenneth Bosomworth, industry observer and president of research and publishing firm International Resource Development Inc , most subscribers to both the Source and CIS do not use any of their computer's power to manipulate data obtained from the systems Thus there is a lot that could be done with these systems that is simply being left undone and untried

In his typically dry manner Bosomworth remarked on the Source and CIS ' If you call being so busy that you re struggling to keep up and that some of your customers can t get into the network trouble then CIS and the Source are in But it's an almost enviable position don't you think?'

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SMALL IS HELPFUL

Rural transportation in Tunisia... camels

[illegible] Third World development [illegible]

The history of mainframe computing in the developing countries during the last 15 years makes fairly grisly reading. It is rife with instances of inappropriately specified hardware, inadequate and frequently irrelevant software and appalling after sales service. Above all, the selling organizations have shown an almost total lack of comprehension of the true needs of the indigenous populations. This has frequently resulted in training programmes for local personnel which virtually preclude any chance of their ever being able to realise the real benefits of their not inconsiderable investments.

It would be naive to dismiss all of this as simply the consequence of over-zealous and commercially motivated salesmen sent out into the Third World by the large mainframe manufacturers in the West. Whilst it must be admitted that this is part of the problem, the real issues are much more fundamental. They relate to the very real problem of experience transfer across the international interface between developed and developing country. This, coupled with the truly remarkable rate of technological progress and innovation in the computer industry, has probably more than anything else caused justification for the view that the developing countries have become a graveyard for inappropriately specified and out-moded mainframe installations.

The computer is essentially a phenomenon of industrialized society. It has been developed in the West for use in the West by people who, broadly speaking, understand the problems of the West. It has been designed for use in an environment where, comparatively speaking, people are healthy, well educated, enjoy a high standard of living in material terms and where population growth has stabilised to manageable proportions. Also (relatively) in the West there is no shortage of highly qualified and experienced personnel, communications are good, information and data exist or else are readily accessible, and the fundamental problem facing society centres on the management and distribution of wealth. To attempt to introduce computer technology in any meaningful sense into areas where none of these conditions obtains raises problems of gigantic proportions, particularly when it is remembered that, in stark contrast to the developed countries, the crucial concern of those in positions of power and responsibility must be to alleviate povetry and hardship.

Such problems are not of course confined to the field of computers. Even in a relatively stable and well-understood area such as the provision of health services to the community, the difficulties are legion. It is all too easy to forget that the remarkably sophisticated health system which we enjoy in this country today is the result of scores of years of successive improvement and refinement and is based upon a fundamental assumption of safe water supply. To attempt to establish a health system based on the British model in a developing country that has not yet had its sanitation revolution, and where the whole complex social and socio-economic infrastructure within which it must function is totally different, will necessitate a major exercise. It must involve not only experts completely familiar with our own health service, but also nationals from the developing country concerned *who are fully conversant with the nature and needs of their own society*. It entails a process of embodying one specific system within the broader metasystem of an alien environment for which it was never designed, and introduces, therefore, the whole concept of *experience transfer*, a concept which goes very much further than the more restricted notion of technology transfer.

By comparison with more traditional approaches to Third World development in such areas as health, irrigation, agriculture, power supply and so on, all of them based on considerable practical experience, the introduction of computer aided technology raises a whole new problem dimension.

Computing has moved so fast in Western society during the last 20 years that its interface even with the environments it was designed to serve is still poorly understood. How therefore is it going to be possible to create effective computer based systems in the developing countries where the fundamental methods of operation are so totally different?

To even begin to answer this question it is necessary to turn again briefly to past experience of using the mainframe computer for planning and analysis in

Third World development. The author has been personally involved in many such initiatives during the past 15 years in South East Asia, the Middle East, Africa and South America and in a wide variety of application areas: health, training, agriculture, irrigation, as well as the more extensive integrated development projects, and all have followed a similar pattern.

Each has started out with the objective of seeking the best overall plan — which implies a need to formulate the problem in a single all-embracing form. This has subsequently led to a major data collection exercise followed by the application of some form of optimisation procedure in order to identify the desired goals. The whole approach is time consuming, costly and to an extent inflexible and whilst it would be wrong to suggest that it has not led to some very real advantages and improvements over more traditional methods of analysis, it has nevertheless not been as successful as was originally hoped. Not only is the whole concept of global optimisation in a rapidly changing multidisciplinary environment of possibly dubious merit, it compels the use of a *large* computer. Frequently there was no alternative but to return to Europe in order to compute — not exactly conducive to a spirit of spontaneity in problem investigation terms. And even when a computer was available locally, those most intimately concerned with the real issues surrounding the project in question were invariably distanced from their line of investigation. They were compelled, through lack of specialist computer knowledge, to depend on uncommitted third parties — the computer experts — for problem analysis and solution. Even after it was realised that large scale optimisation was of only limited value in many aspects of development work, it soon became apparent that a modularised (self-contained part by part) interactive approach was not practically feasible if the computer itself was several thousand miles away from the scene of the problem. In brief, therefore, the mainframe

The Third World

[illegible] handling many of the fundamental problems facing the developing countries.

There are of course those who argue that there is no place for sophisticated computer methods in countries where starvation, disease and unemployment are the burning issues. However, this argument is erroneous and is usually based on ignorance or a desire on the part of those who voice it to protect vested interests. The simple and inescapable truth of the matter is that the developing countries face some of the most difficult and complex problems in existence. They are therefore going to need some formidable weapons in order to fight them. Personal experience gained during the last two years suggests that the microcomputer used in the right way can be a very valuable asset indeed in the whole arena of Third World development.

The micro-computer

The micro computer has all the computing power and memory capacity of the previous generation of mainframe machines, does not overheat and so does not require elaborate air conditioning, requires no more space than that taken up by a small desk, does not require a large team of maintenance and operating staff for its use, is cheap and is comparatively portable. Moreover, with appropriately designed software it can be used after remarkably little training by anyone who is literate. All of this leads to a situation where the decision maker or administrator involved in a large development project

- can personally investigate his own problem in his own way without having to work through intermediaries, in this way reducing the risk of error in problem formulation and interpretation
- can do so in his own office or working environment, so avoiding time wastage and the very real psychological inertia caused by having to travel or despatch information to some distant location
- can do so at times which are convenient to him rather than at a time and within time scales dictated by the mainframe installation
- can examine privately his own ideas or hypotheses relating to his problem without fear of interruption or indeed of appearing uninformed or naive in front of his colleagues

In short, the micro-computer introduces a degree of personal involvement and immediacy in problem evaluation hitherto quite unheard of. Its portability leads to a level of operating flexibility which has enormous potential: it can be used for review meetings, brainstorming sessions or for formal presentations so that criticism or suggestion can be evaluated spontaneously; it can be moved from site to site in the larger development ventures and so can provide an effective tool for project monitoring and control. Finally, because it lends itself ideally to an interactive, conversational mode, exploring all aspects of the project in hand, it allows those charged with the responsibility for development projects in the Third World to gain considerable insight into the intrinsic nature and reality of the problems they face.

It can be seen that most of the difficulties experienced in attempting to use the mainframe computer for development work do not arise with the micro computer. Indeed, all the evidence to date suggests that the micro-computer has enormous potential as a supportive aid in Third World development. However, before this can come about, except possibly in a few isolated instances, several problems mut be faced. In the first place, the micro computer will not come into its own in the developing countries until a satisfactory level of after sales service becomes available. At the present time it is to all intents and purposes non existent.

Secondly, a series of technical improvements are essential if these small machines are to function effectively outside the industrialised countries. They will have to be modified to cope with greater variations in power supply, temperature and humidity. They must be immune from dust and able to withstand quite harsh physical treatment. There are few models currently on the market which would survive a journey in a truck from Goiania into the Mato Grosso in Brazil, for example.

However, these problems are virtually trivial compared with the tasks of training and software development. Little of the software presently available in this country or the United States will be even remotely pertinent to the vast majority of situations faced by those involved in Third World development. What is more, any attempt to distribute it will lead to the very real danger of encouraging those concerned to force problems to satisfy solution techniques rather than to tackle them as they really are. Software will have to be created in a relatively robust, user friendly form, and by people with considerable practical experience of living and working

Livestock in Kenya. Masai boys with cattle

The Third World

in the developing countries. It is a major undertaking which will span many years.

On the question of training, it is not too difficult to set up quite adequate teaching programmes for instructing local personnel in the mechanical use of micro-computers, but this is only the tip of the iceberg. If the micro-computer is not to share the same fate as the mainframe machine in the Third World, then an extensive programme of appreciation courses, preferably based on case study material drawn from experience gained in the country concerned, will have to be launched. It must include courses on systems analysis, econometrics, operational research, financial planning and so on, specifically geared to micro computer application, and will be designed for middle to senior-level government officers in all sectors of economic activity. Also, specific courses must be set up for groups of individuals being trained to take up particular roles in society: regional health administrators, rural development officers, water engineers, for example. The micro-computer might well be introduced in the first instance as a *teaching aid* in the prime field under study. Subsequently, as the course students become aware of its potential advantages in project planning and execution, they should be encouraged, after completing their formal training, to introduce micro-assisted methods into their day to day activities in the field. If past students are then persuaded to retain contact with their former training establishments, a great deal of useful feedback can be amassed in a relatively short space of time. Nevertheless, this whole process will take several years before society really receives its benefits.

Aerial view of Sao Paulo, Brazil

It is important to remember that no matter how good the software and training facilities may be, the real benefits from introducing micro-computers into the developing countries will never be realised unless adequate front-end systems analysis is carried out first. Only in this way will the right machine be chosen to tackle the right job in the right way. Experience in the West shows that there are no short cuts. ■

●Dr Rose has been actively involved in Third World development for the last 15 years. He is currently Managing Director of Metasa Limited, whose subsidiary, Nimrod Consultancy Services, specialises in medical consultancy to the Third World.

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WHEN THINGS GO WRONG

Computers are ideal for continuous process control but humans still need information on what's going on. How this information is provided and displayed is crucial.

A recent article in *The Times* (1) described a Science Research Council project at Newcastle University. The research concerns the design of more reliable computer systems, especially on the software side, and *The Times* article pointed to the value of the research in view of the recent attempts of the Pentagon to fry us all to a crisp. Of the project's origins it was said that it was inaugurated 'when it became apparent that increasingly complicated computer-based systems were being introduced in industry, commerce, government, administration and defence before they could be cleared of all design faults'.

The introduction of new technologies has always caused problems for the people who operate processes. Increases in sophistication, which are fine and beneficial whilst equipment continues to operate smoothly, tend to carry heavy penalties of increased difficulty of diagnosis and repair of faults in the event of breakdown. (Would you rather repair a bicycle chain or a car engine?) However, the introduction of computer-based technology appears to have brought rather more than its fair share of problems, especially in its introduction to industries where its benefit should be felt most, those capital intensive processes potentially dangerous to the human operator (because of factors such as intense heat, pressure, dangerous chemicals or radioactivity).

It could be a simple artefact of the American legal fashion to sue any corporation, company or individual with more than a million dollars in the bank, but some of the manufacturing giants such as IBM and DEC are actually pulling out of the market for supplying systems to high risk industries, such as the nuclear power industry. That is not to say that their equipment will not be found in these industries in future. However, it will probably have been supplied indirectly through an OEM with a smaller turnover who is thus less likely to be sued. This attitude seems to reflect a basic mistrust of the capability of computer technology to cope with the problems of controlling high risk processes. Why should this be?

Firstly, it should be pointed out that most of the industries in question actually have a very good safety record. Disasters or near disasters such as the explosions at Seveso (Italy) and Flixborough (England) or the shambles of Three Mile Island (USA) are relatively rare, but tend to make headlines when they do occur because their effects can be widespread and dras-

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tic. Because of this good safety record, faults in processes are few and far between. However when they do occur they must be located and dealt with quickly and efficiently.

We thus have a paradox: we expect operators to be able to master a situation with which they have had little previous experience or, indeed, that could not have been envisaged in the first place. The problems of design faults mentioned earlier in respect of computer based systems apply equally to other complex chemical and physical processes. We have no real idea beforehand exactly what combinations of circumstances are likely to crop up, thus we cannot predict with any certainty what faults operators should be trained to identify and correct. Even if we think we know what will happen if some component of our system fails, we cannot account for all the factors that might modify the situation. Bleriot managed to cross the Channel in 1909 with an overheating engine, something we might predict would cause a plane to lose power and crash; the reason that he did not was that an unpredictable environmental factor, the weather, changed the circumstances. It rained – thus cooling the engine. Thus knowledge of the system itself is insufficient: we must also have information and the ability to predict environmental effects on the system.

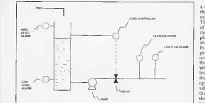

FIGURE 1

Mundane tasks

The problems associated with the introduction of computer technology to the control of these processes are not necessarily the ones we might imagine (eg: Crazed Computer Causes Nuclear Catastrophe and Sends Bill to Essex Consumer). Computers, in fact, are largely used for mundane tasks such as data logging, and do little besides collect and store data which the operator can then retrieve as and when it is needed. In some processes, computers are used for jobs such as the control of ingredient mixing, or of scheduling the production of batches of a product, which might be anything from breakfast cereal to steel ingots. However there are few instances of fully automated processes where computers decide what has gone wrong and what remedial action should be taken when a fault occurs. This task is generally left to the human in charge of the process, or a human is usually always available to take over when the machine fails to cope.

To be able to perform the function of fault diagnosis, the operator has to be provided with information about the state of a process. With traditional hardware-based instrumentation, an operator would typically have a control room where a whole wall might be devoted to instruments telling him about temperatures, levels, pressures, flows and the like at various stages of the process. This information is needed because various parameters have to be recorded routinely; however, it is not necessarily the information the operator needs when he has to locate a fault *in a hurry*. To illustrate the problem faced by the operator, consider Figure 1.

This shows a simple example of a control loop, an automatic level controller. This is fairly typical of the level of automation of a lot of plants, all done in hardware. Liquid is flowing into the tank from the feed; in order to keep the amount of a liquid in the tank at a desired level (the set point) a valve is opened and closed on the outlet line by the controller. Thus if there is too much liquid in the tank the valve is opened and more liquid is pumped away; if there is too little the valve is closed and the tank starts to fill up again.

Figure 2 shows the information that an operator would typically see in a control room (although not necessarily collected together as it is here). A flow recorder charts the rate of flow through the output line. The level control instrument displays the level of liquid in the tank relative to the set point and the position of the valve. There are three alarms — one for a high level in the tank, one for a low level, and one for a low flow through the output.

Various things can go wrong with even a comparatively simple control loop like this. The pump can fail. The valve can jam causing the tank to fill or empty too fast. The feed to the tank can fail, causing loss of flow through the outlet. When one of these faults occurs, the information displayed in Figure 2 does not allow the operator to see *immediately* that it is the pump that has failed, or the feed that has stopped, or whatever. In fact, in these two instances, there is no direct information on the panel *at all*! The operator must infer what is happening by using his knowledge of the way the loop works. Thus, if the level is high and causing an alarm, the operator must check to see whether the valve is open and there is a proper flow through the outlet. If the valve is open but the flow is very low, it means that the pump is not working. If the flow is right for the valve position but the valve is more closed than it should be for the level, it means that there is something wrong with the valve – it is not acting as it should be.

Now imagine a control panel with several different loops of this kind. Also suppose that the output of one tank is the feed to further tanks, so that a fault in one tank would *refer* its symptoms on elsewhere, to tanks further down the line. The operator must now work out which control loop is referring its symptoms to other parts of the system before diagnosing the problem within that control loop.

One final complication: Control loops can be used for a number of things other

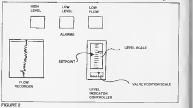

FIGURE 2

than level control There are controllers for other parameters such as temperatures and flows, and more complex, higher order, controllers such as ratio controllers or cascade controllers Furthermore the way in which two control loops work can vary although they may nominally be controlling the same parameter For instance two separate temperature controllers may in one case regulate the flow of coolant or in the other the flow of a heating agent such as steam Thus in the first case if there is a high temperature, a high flow is appropriate in the second case it is not All these factors go to make the operator's job extremely difficult when he is faced with an urgent fault repair task for he must have an encyclopaedic knowledge of the structure of the plant in terms of flows, processes and so on, to be able to tease out the relevant information from the irrelevant

It might be thought that the introduction of computers into the monitoring of industrial processes would be useful in that it should be possible to present some of this information in a more palatable form or even to get the computer to diagnose faults without the operator having to intervene However, by and large the computer has merely been used as a more reliable measuring instrument and essentially the same information as before is monitored and displayed In some ways the computer has made the situation worse With traditional information systems the available information was all displayed simultaneously and continuously on a control panel The main drawback of this is the amount of irrelevant information obscuring relevant information, on the other hand there is a lot of *pattern* information available, which humans are remarkably good at dealing with

Computers have potentially changed that The information is now stored 'invisibly' and must be called up by the operator using a graphics terminal or a simple vdu Thus we get round the problem of irrelevant information, however we must now rely on the operator to know what information is relevant and call it up There are worrying indications that even when all the information is available operators tend to get "cognitive tunnel vision" and to concentrate on a particular area of the system which they *think* contains the fault – ignoring things happening elsewhere which indicate that they are completely wrong in their hypothesis The use of data retrieval systems may aggravate this tendency to a greater degree since such information is stored away where the operator is unlikely to realise it even might be relevant

A second problem seems to be that the power of computers has simply led to the collection of more and more information rather than its compaction into more manageable chunks Information might be power but only if we can handle it It is reported that at one stage during the crisis at Three Mile Island so many alarms were being reported that the terminal on which they were logged was running with some considerable lag behind real time! This sort of thing seems to be simply a misuse of the

Fault Diagnosis

information processing power of the computer

So what could be done to improve the use of computers and consequently the reliability and safety of high risk processes? There are continual suggestions that if these processes cannot be operated safely by humans we should automate them to a greater degree However, we must bear in mind that much human error is a consequence of our failure to present information needed by the operator in a palatable form If it came down to a choice between living next to a nuclear power plant operated by a computer and one operated by a human I think I would still choose the latter the basic unpredictability of human high technology means that humans use heuristics to control its performance, and we can only give the same heuristics to a computer if we want it to do the same job

Fuzzy controller

The experience of artificial intelligence researchers seems to indicate that computers are relatively poor at dealing with the sorts of heuristics used efficiently by humans eg in pattern recognition Unless there are drastic changes in hardware or software technology so that computers become far more efficient parallel processors it is unlikely that very efficient automated fault diagnosticians will be built certainly they will be no more efficient than a human operator on a good day

shape and mould information into a form that the operator understands For instance an operator would not say – "we have a temperature of 2000°C in here when it should be 1000°C he would more probably say that it was getting "far too bloody hot"! There have been attempts to get computers to control processes using this so-called "fuzzy logic" and these have proved successful using fairly simple processes (A research group at Queen Mary College in London have produced a 'fuzzy controller' whose decision rules can be modified by the operator (2)) This is quite a useful step forward in that the operator and the control computer can now "talk" about parameters in the same

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imprecise terms However, it does not seem, on the face of it to provide much help to the operator working under pressure and trying to infer what is happening from information which is not directly related to the problem

One direction in which computers might be exploited is in their use to produce compound variables which describe higher-order features of the system from traditional parameters The problems of control loop diagnosis were described earlier in this article Now, it might seem self-evident, but all control loops have the common feature that they are attempting to *control* something We *could* get a computer to integrate all the information from a control loop and to give us a composite measurement of its performance

This need only have three values **"under control** **moving off set point but taking appropriate action** and **"moving off set point and taking inappropriate action** The use of such a variable would then enable the operator to look at the control loops of a plant, regardless of whether it was temperature flow or level that was being controlled and immediately recognise which sections of plant were under control and which were not without having to go through lengthy inferential processes We at UWIST are planning to investigate the feasibility of such exploitation of software flexibility, and how acceptable such presentation would be to operators

A second possibility, which is more complex and probably more difficult to implement is the use of expert systems Donald Michie suggested in an article in *Computer Weekly* that an expert system could be used in controlling the type of complex processes we are discussing here such a system would have a repertoire of rules and heuristics which it could use to assess information, predict likely consequences, and advise the user of these predictions However, such an expert system would not have full responsibility for making a diagnosis of a fault it would only suggest options The feasibility of such an approach has been established using limited databases such as the classification of lunar rocks, by Woods and others at Bolt Beranek and Newman (3) Before investing effort in such a project, however, there are questions that should be raised about the extent and the acceptability of belief in computer predictions by computer users This topic and the whole question of division of responsibility between man and computer is discussed by Fitter and Sime in a recent collection of articles on interaction between humans and computers (4)

'In some ways, the computer has made the situation worse'

Returning then to the suggestion made in *The Times* mentioned at the beginning of this article it is not necessarily the use of untested complex computer-based equipment that is causing problems in industry, commerce and so on I have tried to illustrate in the context of process control that at present, the introduction of computer-based systems does capitalise on information processing technology to improve the lot of the operator but in general uses the additional power to compound the mistakes made in traditional information systems The consequence of this is that what was just manageable before is becoming unmanageable now We should start thinking of ways to get round these problems now before the situation worsens ■

References

(1) *University Seeks Improved Computer Reliability* Pearce Wright The Times 11 6 80 (2) *An Experiment in Linguistic Synthesis with Fuzzy Logic Controller* by E H Mamdani and S Assilian Int Journal of Man Machine Studies 1975 7 1 13 (3) *The Lunar Sciences Natural Language Information System Final Report* by W A Woods R M Kaplan and B Nash Webber Bolt, Beranek and Newman report no 2388 1972 (4) *Creating Responsive Computers Responsibility and Shared Decision Making* by Mike Fitter and Max Sime In Human Interaction with Computers Edited by H T Smith and T R G Green Academic Press 1980

●*Dr Brooke is at the Department of Applied Psychology University of Wales Institute of Science and Technology Cardiff Wales*

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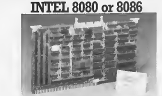

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BRAND NEWs compiled by Microspy with Anthony Esgate 10

This middle section may either be pulled out or photocopied then filed for reference. It will be comprehensive and range over the whole field of products, services, events and courses. **PU** stands for Personal User. **SB** stands for small base – that is, small budget or small business. **MB** – medium base, medium budget or medium business. **BB** – big base, big budget or big business. **Addresses** are to be found at the end of **Brand News.**

EUROMICRO 80

The European Association for Microprocessing and Microprogramming

The Sixth Symposium and Exhibition on Microprocessing and Microprogramming

Venue: Imperial College, London

Date: 16-18 September, 1980

Advance Program

EUROMICRO 80 is the sixth in a series [illegible] organised by the European Association for Microprocessing and Microprogramming (EUROMICRO). Earlier events were held in Nice [illegible], Venice [illegible], Amsterdam 1977, Munich [illegible] and Gotenburg 19[illegible]. The Sixth Symposium of Microprocessing and Microprogramming will be held in London from 16th-18th September 1980. It will follow the successful arrangements of the preceding symposia and will consist of a scientific program and an industrial program, together with an extensive exhibition. It will be supported by a tutorial and will be the host for the European Micromouse Competition.

The annual EUROMICRO symposium is the leading European forum concerned with microprocessor systems and microprogramming. It is a focus for the interchange of developments between university and industry. It attracts contributions as well as delegates from nearly all European countries, the United States and the Far East.

Scientific Program

The scientific program at EUROMICRO 80 includes a keynote session with invited papers from leading experts in their field, followed by [illegible] submitted papers and three panel sessions. An extra feature this year is the inclusion of short note sessions which have been included to allow topical reporting of some recent work which is relevant in the field of hardware and software.

Keynote addresses will be given by:

Dr C R Vick, the Director of Research and Development in Computer Science and Engineering for the Ballistic Missile Defence Advanced Technology Centre in Huntsville, U.S.A., Professor I M Barron, who founded Computer Technology (CTL) and is now Director of Strategy for INMOS, the new UK microelectronics company, and Professor Joseph [illegible], Professor of Organisation and Management at the University of Nijmegen, Director of GITP (Consultants on Personnel Policy, Organisation and Management).

The submitted papers have been carefully refereed by at least three experts and were selected by the Program Committee from a large number of submitted contributions. The accepted papers are related to Distributed Processing, Design of Microcomputer Systems, Microprogramming and Firmware, Applications with emphasis on Problems and Techniques.

Sessions have been organised in parallel in order to fit the program [illegible] the time available. The Program Committee has been very careful [illegible] possible conflicts of interest.

Tutorial

The tutorial subject [illegible] with a number of aspects of the high [illegible]. The tutorial will be on 15th September [illegible] as the symposium.

Exhibition

This year considerable care has been given to the mounting of an exhibition which is particularly relevant to the subject of the Limited. It is located in a hall adjacent to the lecture theatres and will be

Micromouse Competition Finals

Wednesday 17th September will be the date of the finals of the Micromouse competition first devised by **IEEE Spectrum.** This will be held as an integral part of the EUROMICRO 80 event in the same location as the scientific sessions. Over 100 entrants have been registered for this competition and the most successful will be featured in the finals.

The European Finals of the Amazing Micromouse Maze Contest will be held during the Euromicro Conference at Imperial College between 16th-18th September 1980 and over seventy contestants have entered from as far afield as Finland, Italy and the United States. The micromice are in fact microprocessor controlled robots which must find their way through the six and a half inch wide alleyways of a ten foot square maze. The mice are battery powered and completely self contained. They must receive no help from their owners in finding their way to the centre in the shortest possible time. Unlike the children's picture book mazes, there will be many different paths leading to the centre, some very much shorter than others, and a mouse with insufficient intelligence could easily find itself travelling round and round a loop. When the contest was first held in the United States by I.E.E.E. Spectrum, the target was a maze exit. Unfortunately, this meant that a simple minded wall follower could be guaranteed to find its way through the maze albeit by a rather lengthy route. With a centre target, the Euromicro Maze can guarantee that only a mouse with intelligence can be sure of finding its way, whilst wall followers will be disconcerted to find themselves back at the entrance.

Although it has its light hearted side, the contest is being taken very seriously by contestants and judges alike. Electronics firms, large and small, will certainly use the event as an opportunity for talent spotting. It is not simply the substantial prizes which have brought contestants all the way from America – after all, one of the major prizes is a trip to the United States! **(John Billingsby.)**

open to all delegates throughout the conference. The ... stand ... be used by hardware manufacturers and software experts to exhibit their equipment and capabilities. There will be particular emphasis on microcomputer systems, development tools, test systems and peripheral devices.

Further information on the exhibition can be obtained from: EUROMICRO 80 Exhibition, Temple House, 36 High Street, Sevenoaks, Kent, England TN13 1JG.

Industrial Program

Papers presented by exhibitors will be given in the industrial program. These sessions will run in parallel with the scientific program. All delegates may attend these sessions at their choice. The complete program will only be available at the time of the symposium in order to give the organisers, as well as the exhibitors, the opportunity to present their most recent products and developments.

SEE PREVIOUS PAGE
MAZE CONTEST

Tuesday, September 16, 1980

10 00

A. KEYNOTE SESSION Chairman L Thompson (GB)
EUROMICRO 80 Welcome address Sir Ieuan Maddock CB OBE FRS
C R VICK
A NEXT GENERATION OF SUPER COMPUTERS FROM MAINFRAME TO MICROS

11 30

B KEYNOTE SESSION Chairman Mariagiovanna Sami (I)
I BARRON
THE DECADE OF THE MICROCOMPUTER
J A VOLLEBERGH
SOCIAL IMPLICATIONS OF MICROELECTRONICS

14 00–15 00

C1 FIRMWARE ENVIRONMENT Chairman H Berndt (D)
A LIST DIRECTED FIRMWARE SUPPORT FOR HIGH LEVEL LANGUAGES
J P Santonnet M Castan C Percebois (F)
HIGH SPEED TRANSPOSITION TECHNIQUE FOR MICRO PROCESSOR ARRAY PROCESSING ATTACHMENTS
A C D de Figueredo E Sá Marta, J G C e Silva (P)

C2 SPECIAL APPLICATIONS Chairman P Le Beux (F)
DIGITAL POSITION CONTROL BY MEANS OF A DEDICATED MICROCOMPUTER
J Billingsley H Singh (GB)
PERSONAL COMPUTERS IN PHYSIOLOGY
C J van Spronsen O Rompelman (NL)

15 30–17 00

D1. MICROPROGRAMMABLE MACHINES Chairman L Richter (D)
UKKO A DYNAMICALLY MICROPROGRAMMABLE COMPUTER
M Kivikoski M Lehto Y Neuvo (SF)
A MICROPROGRAMMABLE MULTIPROCESSOR ARCHITECTURE FOR SIMULATION
C O Alford M R McQuade (USA)
EMU A BIT SLICED MICROPROCESSOR BASED EMULATOR
F Vajda (H)

D2 PANEL Chairman T Holtwijk (NL)
WILL THE EUROPEAN IC INDUSTRY ONLY BE SECOND SOURCING?
Representatives of leading European companies including EFCIS INMOS Mackintosh Phillips and Siemens will give their views on product developments in this area

Wednesday, September 17, 1980

09 30–10.30

E1 LARGE SCALE MULTI MICROPROCESSORS Chairman F K Hanna (GB)
SUPERSYSTEMS IN THE 80 s BASIC CONCEPTS OF DESIGNING
Svetlana P Kartashev S I Kartashev (USA)
DISTRIBUTED PROCESSING FOR DEDICATED SUPER SYSTEMS
H M Minshew A A Mullin (USA)

E2 SHORT NOTES SESSION Chairman S Husson (USA)
Contributors will be announced during the symposium

11 00–12.30

F1 APPICATIONS IN TELECOMMUNICATIONS Chairman M Yoeli (Israel)
EMMETT THE KERNEL OF THE MULTI PROCESSOR OPERATING SYSTEM FOR A SMALL LOCAL EXCHANGE
M C ccott M Papa C Salati (I)
A MICROPROCESSOR APPROACH TO SWITCHING COMPUTER ARCHITECTURE
H Berndt (D)
ONE APPROACH TO A MULTI PROCESSOR IMPLEMENTATION OF A MODEM FOR DATA TRANSMISSION OVER H F RADIO
V Milutinovic R Paunovic S Nedic et al (Y)

F2 COMPUTER AIDED DESIGN Chairman J D Nicoud (CH)
A MACHINE INSTRUCTION LEVEL CONCURRENT SIMULATOR FOR MULTI MICROPROCESSOR SYSTEMS
A R Meo M Mezzalama P Prinetto (I)
DECISION TABLES APPLICATIONS TO MICROPROCESSORS AND SOME IMPLEMENTATION METHODS
P Ercoli (I)
COMPUTER AIDED DESIGN OF MICROPROGRAMMED CONTROL UNITS WITH SANDRA
K Waldschmidt R Fahrrich D Tavangarian (D)

14 00–15 00

G1 MULTI MICROPROCESSORS Chairman S I Kartashev (USA)
TOWARDS INTERRUPT ASSIGNMENT FOR MULTIPLE PROCESSORS
K Muhlemann (CH)
SOFTWARE DEVELOPMENT AND DEBUG AIDS FOR THE MULTI MICROPROCESSOR SYSTEM
G Conte F Gregoretti (I)

G2 TEXT PROCESSING Chairman W Guggenbuhl
A MULTI MICROCOMPUTER SYSTEM FOR INTEGRATED TEXT/IMAGE PROCESSING AND COMMUNICATION
Schelterer (D)
A MICROPROGRAMMABLE CHARACTER GENERATOR FOR A CRT PHOTOTYPESETTING SYSTEM
M Tervonen (SF)

15 30–17 00

H1 DATA BASES Chairman T Skard (N)
AUTOMATED DATA SEARCH SYSTEM SARI
J C V ault (F)
MICROPROCESSOR ASSISTED DATA BASE MANAGEMENT
H A Freeman J R Jordan (USA)
A GENERATABLE TRANSACTION SYSTEM FOR MICROCOMPUTERS
G Kronert (D)

H2 PANEL Chairman J Wilmink (NL)
EDUCATION
The panelists will include
D Aspinall (GB) G Musstopf (D) J N Nicoud CH J C Simon (F)

09 30-10 30

J1 INNOVATIVE ARCHITECTURES Chairman R Zaks (F)
VERTICAL PROCESSING: THE EMULATION OF ASSOCIATIVE AND PARALLEL
A Bode (D)
A FLEXIBLE CIRCULATING MEMORY FOR COMMUNICATION IN A MULTIPROCESSOR
B Peltprez (F)

J2 INDUSTRIAL CONTROL Chairman M Sloman (GB)
A DISTRIBUTED CONTROL SYSTEM FOR INDUSTRIAL PLANTS
J M Ayache B Carrichon M Devy M Diaz B Potin M Shapiro (F)
MICROPROCESSOR ARCHITECTURE FOR INDUSTRIAL CONTROLLERS
C A Tendulkar B Muller (D)

Thursday, September 18, 1980

11 00–12.30

K1 SHORT NOTES SESSION Chairman L Rispoli (I)
Contributors will be announced during the symposium

K2 LOCAL NETWORKS Chairman F Vajda (H)
A LOCAL MICRO NETWORK TO SUPPORT SOFTWARE MODULARITY
J Deckmann R W Hartenstein (D)
SIMULATION OF RING NET AND STAR NET FOR A DISTRIBUTED PROCESSING SYSTEM
G L Reijns Th Bruins W G Vree et al (NL)
AN X-25 BASED LOCAL AREA DATA NETWORK
F Halsall A J Ruela A Al Jaff (GB)

14 00–15 00

L1 STANDARDS Chairman C J van Spronsen (NL)
CALM 2 AN UPDATED COMMON ASSEMBLY LANGUAGE FOR 16 AND 32 BIT MICROPROCESSORS
J D Nicoud (CH)
MICROPROCESSORS BUS STRUCTURES AND STANDARDS
P Borrill (GB)

L2 SYSTEM SOFTWARE Chairman O Caprani (DK)
DYNAMIC DECENTRALISED LOAD LEVELLING
C Hammerstrom P Hall (USA)
AN ORIENTABLE PLZ COMPILER AND INTERACTIVE DEVELOPMENT SYSTEM FOR MICROCOMPUTERS
R Bonsignor A Converti S Crespi Reghizzi et al

15.30–16 30

M1 VLSI AND TESTING Chairman R W Hartenstein (D)
A MULTIPROCESSOR ARCHITECTURE ADAPTED TO VLSI DESIGN
J M C Alves Marques (F)
FLEXIBLE TEST METHOD FOR MICROPROCESSORS
C Robach G Saucier R Velazco (F)

M2 USER MICROPROGRAMMING Chairman G Chroust (A)
USER MICROPROGRAMMING IN AN EXPERIMENTAL POLYPROCESSOR SYSTEM-EPOS
A Maeda I Yamazaki A Tanaka (Japan)
ON THE DESIGN OF A MACHINE DESCRIPTION MODEL AND COMPACTION ALGORITHM FOR MICROCODE GENERATION
P Ma T Lewis (USA)

16.30–170.00

N CLOSING SESSION Chairman L Thompson (GB)
MICROMOUSE PRIZEGIVING
Adjudicator P Hammond (GB)
CHAIRMAN S CLOSING REMARKS●

Symposium Site

EUROMICRO 80 will be held at Imperial College London in the Royal Borough of Kensington and Chelsea about three miles west of Piccadilly Circus. The area is largely residential developed graciously in Georgian and Victorian times. Parks and museums are a special feature of the locality. Kensington Gardens, Hyde Park and the Serpentine lake are all within a few minutes walk of the College with the Victoria and Albert, Science, Geological and Natural History [illegible] The [illegible] Ro[illegible] adjoins the campus. Communications to the West End and principal railway terminals are good and the West London [illegible] a five minute walk away. The shopping centres of Knightsbridge and Kensington are only a short bus ride away. In contrast to these surroundings Imperial College is very modern. Most of it has been rebuilt since 1953 and its new buildings offer excellent amenities.

Speakers Corner

A meeting area will be set aside for informal discussions on specialised topics. A notice board will be designated for prospective speakers to announce their topic and suggested time in order to attract other participants.

Tutorial

The subject for the tutorial is ADA. Mr John Barnes will deal with the more significant aspects of this new high level programming language. With the declared intent of the US Department of Defence to adopt this language exclusively for the US Armed Services it will undoubtedly impinge significantly on the development of systems in Europe during the next few years. Furthermore a strong European influence in the development of the language, particularly by CII Honeywell Bull whose 'Green' language is ADA makes the subject most appropriate for the Euromicro supporting program.

The tutorial will commence at 9 30 on 15th September and will have two sessions approximating to six hours in total. Registration will take place on the morning of 15th Sept in the Ante room of the Sherfield building at Imperial College.

The lecture will be held in the Lecture Theatre A of the Huxley building.

The cost of the tutorial which includes extensive printed notes, Lunch and Coffees is £75. For delegates who register before 9th August the price is £55. Use the Registration slip below for taking part in this tutorial.

Early registration is recommended as numbers are being strictly limited.

Mr John Barnes of Systems Development Limited has had long connections with the development of ADA and was one of the co-designers of the language. He has remained in contact with its development and is eminently qualified to give this tutorial.

EUROMICRO '80: EXHIBITORS LIST

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Applications

ACT PETSOFT

Low cost range of business packages for CBM PET Written for ease of use with many prompts and full instructions by either PETSOFT itself or external specialists Includes PETSOFT STOCK £75 PAYROLL 200 or MICROPAY 200 (see Intex) payroll packages £50 and £195 respectively SALES ACCOUNTING £120 PURCHASE ACCOUNTING £120 WORDCRAFT the acclaimed word processing package £325 VISICALC the celebrated numerical problem solving package £125 PETPLAN Business Simulation management training package £50 *SB MB (PET)*

BRAND NEWs

ADDS (UK) LTD
IMPAUT package based on ADDS System 75 small business machine for shippers and freight forwarders Hardware utilizes 2 disc drives (at least) plus a Centronics printer fitted with a form feed unit Front feed handles C10 and C10A forms supplied by H M Customs and Excise and work sheet is printed out on standard computer stationery in a format acceptable for Customs clearance Users enter information via screen on which lists of headings are displayed Rates of exchange are keyed in daily User is then guided by system Benefit of ADDS system is resident operating system which allows randomly indexed file structure necessary for rapid retrieval of consignment data INPAUT saves time through storage of large static database including tariff codes consignors importers places of discharge charge descriptions VAT rates etc System calculates sterling equivalents supplementary and proportionate charges and surcharges against each tariff item in a consignment Other documents produced by IMPAUT include file folders out of charge notes delivery notes and invoices From £12 000 *Shippers Freight Forwarders ADDS)*

CLENLO COMPUTING SYSTEMS LTD
PEARL Application Generator software package for use on a wide variety of microcomputers Designed and produced by PATHWAYS UNLIMITED of U S A PEARL (Producing Error Free Automatic Rapid Logic) written in CBASIC2 runs under CP M Enables programmer to reduce programming time by automatically generating CBASIC2 code required for file creation input edit and output Also compiles CBASIC2 code generated User required only to define structure of file or files to be used and names and characteristics of the individual data elements PEARL requires 48K RAM minimum two min 163K disk drives and a 132 column printer 3 levels Level 1 for hobbyists Level 2 business assistant for business applications Level 3 for software developers priced at £90 £325 and £625 respectively Lower levels are upgradeable *PU SB*

COMPUT-A-CROP
Distributors for BOTTOM SHELF range of software for TRS 80 Includes Information System Data Manager Business Mail System Text Merge Math Pack DMS Utility General Accounting Systems Analysis Pad Check Register Accounting System Checkbook II Budget II System Utilities Terminal Control System Doctor Toolkit Also general software and support items *PU SB (TRS 80)*

COMPUTER ANCILLARIES LTD
DURANGO disk based portable micro computer for business now accepts CP/M operating system and C BASIC FORTRAN and Pascal languages making a substantial library of existing software available for implementation *SB MB*

COMPUTER ANCILLARIES LTD
STARTEXT Word Processing Program added to program packages for DURANGO portable small business microcomputer (existing capabilities include sales order/ledger invoicing stock control payroll purchase ledger nominal ledger job costing) Startext offers corrections to a printed letter with reversions to original text when necessary justification of copy into selected column widths replacement of selected dates phrases or clauses with variables and changes of paragraph order Durango which is being installed at the rate of 10 a month features 64K central processor two random access mini diskette drives VDU with input keyboard and 165 character bi directional printer with high standard of print finish and costs from £7 500 *SB MB*

CONTROL DATA
CDIAS — Control Data Information Analysis Services new database information system provides notation method and software for development of large scale databases Uniqueness of system lies in ability to address relationship between information with software programme Concentrates on precisely defined information and user participation in common problem solving exercise using linguistic techniques Based on a conceptual scheme — a method of notation to describe data its elements and relationships to other data providing essential framework for database Notation method is expressed in natural language for processing on software programme designed for information analysis Programme operates under Network Operating System of CDC s large computers in batch remote batch and time sharing mode Related products and services including seminars and training courses to be announced *BB*

ORG BUSINESS MACHINES
Printers packages for CADO business micro computers Includes job history directory extended invoicing facility and an integrated mail order addressing records package Job history program gives cross referenced file of past work with records identifiable by customer number job number and date File can be accessed on line at any time Records retrieved can be printed out or used as used as reference to work day number Invoice description program allows free form citations to be raised without affecting amounts total or V A T Mail order package dedicates a file to each stock line allowing customer and order details to be entered Quantities and amounts are automatically accumulated into master record existing customer records identified and updated and management summary and bank reconciliation reports produced Address labels are printed out in post code order Designed to run in parallel with Cado business software *Printers (Cado)*

EQUINOX
Market OMNIX the multi user multi-tasking operating system for Z80 based microcomputers Supports software already written for CP/M Developed by 1500 Systems Ltd *OEM Systems Designers (Z80)*

FARS COMPUTER SERVICES LTD
FINAPL APL based financial modelling system for building up very effective corporate models for budgeting company planning investment appraisal and financial strategy Sensitivity function investigates effects of user specified changes in data values while a backwards function looks for changes in data values necessary to bring about user specifiable end results Available for any Harris DEC10 or 20 IBM or IBM compatible machine supporting an APL interpreter system costs from £10 000 Also available to users of IP Sharp and GSI time sharing bureaux *MB BB*

HEWLETT-PACKARD
New capabilities available for HP Series 9800 desk top computer family include data base management system data communications and assembly-language capabilities Data base manager available for top of-range System 45 desk top computer has 2 main components — data base structures and QUERY/45 a user orientated inquiry program Assembly language is designed to provide speed increases in time-critical portions of BASIC programs (also for System 45) Datacomm package for both Systems 35 and 45 allows desk tops to emulate terminals in order to communicate with mainframes whilst retaining full computational capabilities Asynchronous Datacomm package is an interactive link with HP1000 and 3000 systems as well as most other time-share computers Synchronous package provides communication with machines supporting IBM 2780 and 3780 RJE terminals (this version also supports main storage units printers and other devices to be used as terminal input and output devices All three available as ROM or combination of ROM and software (Datacomms package includes an interface card) *MB BB*

INTEX DATALOG LTD
Formed in 1978 as an associate of two small manufacturing companies Intex (Radio graphics) Ltd and Intex Plastics Ltd and particularly interested in the applications of microcomputers to small businesses Authorized dealer for Commodore PET and all related products including business software one of the country s seven main dealers for A C T and CompuThink products including A C T business software and a dealer for Apple and Nascom equipment Intex has itself produced MICROPAY 200 a complete payroll system for 32K PET system with dual floppy disk drives and printer System provides weekly/monthly payslips summaries of all payments and deductions for month and year and weekly/monthly cash analysis slips for all cash payments made System copes with up to 200 current employees and all technicalities associated with tax National Insurance overtime bonus holidays etc Also included are routines to list details of any or all employees sort employees into alphabetic or departmental order and produce P45 or P60 information *SB (PET*

LIFEBOAT ASSOCIATES
CBS (Configurable Business System) data management system for microcomputers that allows true transaction processing Custom accounting systems for payables receivables stock order entry and general ledger can be set up without using any programming languages CBS can define an application by specifying master files Transaction files can then be used to describe activities Data entry program is used to enter information and an update program can process transactions against master files updating balances and stock levels System features comprehensive report generator

which can be used to produce invoices purchase orders re-order reports mailing labels or other reports Requires CP/M compatible system and at least 48K of memory Does not require any support languages Documentation and demonstration stock control system are supplied £165 plus VAT Documentation alone £30 *SB*

SOLARTRON SCHLUMBERGER INDUSTRIAL SYSTEMS
Marketing software written in CEGB Swepspeed computer language in support of its microprocessor based control systems for Process Control Power Generation and Engine Testing Applications Complementary to Solartron IMAC (Industrial Measurement and Control) soft/hardware packages but also allows customer personnel to write and modify their own multi tasks programs for IMAC as required Swepspeed is an on line real time language highly suited to industrial and engineering display and control systems It combines features of BASIC FORTRAN and other computer languages Permits from 1 to 99 tasks to be carried out apparently simultaneously (eg simultaneous sequencing data acquisition data checking automatic control and response to manual pushbutton override etc) Tasks compile to object code Integer and floating point string variables supported Any job can be allocated a priority and also protected against unauthorised interrogation Other features include online monitoring facility online development industrial systems support colour display support and mass storage support. *BB Industrial*

SYSTEMATIC INTERNATIONAL
Range of Pascal based general accounting packages for Apple 2 and ITT 2020 micro computers Pascal gives more user disc space and faster processing than can be achieved with other commonly used languages Three systems currently available General Ledger Sales Ledger and Purchase Ledger separately or in an integrated package Hardware and suite of programs available from £4000 SI also offers 2-day microcomputer training courses and a bureau service based on a Prime 400 *SB MB (Apple/ITT)*

TANDEM COMPUTERS LTD
ENCOMPASS distributed data management sytsem makes on line applications as easy to write as batch by giving users of Tandem Non Stop (tm) Systems total transaction processing and distributed data base control in one comprehensive software package Includes distributed audit trails transaction backout over a dispersed data network automatic dump of audit files on line backup enhanced network—wide transaction control facilities and software utilities for recovery of geographically distributed data base files in the event of logic errors in a program or communications failure Also included are previously available software for front end control of multiple terminals various line protocols screen formatting and sequencing data validation transaction definition and application control data dictionary and a query language and report writer Performs terminal management data base control and transaction logging and auditing as automatic system functions Transaction Monitoring Facility (TMF) ensures that many different files accessed or modified by a single transaction which may affect data stored in multiple locations are monitored guarantees that data base is kept consistent ENCOMPASS also allows recovery from component or software failure *BB*

BRAND NEWs

TEXAS INSTRUMENTS
Video Chess command module for Texas Instruments Home Computer TI 99/4 First class graphics with readily identifiable pieces Chess clocks are displayed along with latest move made Largest program so far developed for TI 99/4 developed with assistance of International Master David Levy

3 levels of skill and 3 playing styles — normal aggressive and passive Moves are entered in normal notation Machine's help can be sought at any time Up to 9 games can be played simultaneously with different levels of skill and styles En Passant capture castling pawn promotion all permitted Mistake correction action replay and freeze facilities provided Computer can be set up to solve problems such as mate in two Complete or unfinished games can be stored Module costs £44 95 computer about £990 *PU (TI 99/4)*

VDUs, Graphics, Terminals & Systems

APEX MICROSYSTEMS
MHP 01 miniature hexadecimal keypad miniature 68mm x 67mm for use in portable data entry Matches ASR33 alphanumeric keyboard Two units together give an expanded ASR33 layout with area 235mm x 67mm Gives fully encoded 4 bit parallel BCD output Strobe and Enable interface allows fully synchronous or asynchronous data entry and hand shake routines with optional tri state or latched outputs On board clock standard Also provision for external clock for synchronous data entry Keypad has detachable bezel and features tactile response keyswitches and 2 key lockout protection *MB OEM*

KIRBY-LESTER ELECTRONICS LTD
PCT 14 System a business terminal for the G P O Prestel information system linking the television telephone and computer Displays Prestel viewdata Ceefax Oracle or on air television reception Convenient page selection or 2-way communication is via an integral alphanumeric keyboard Printer interface standard also connects to any tape recorder video cassette recorder or standard T V to display at two locations simultaneously A VDU mode allows operator to create pages of information without incurring computer charges and Prestel information can be modified using any colour/graphic combination Available by purchase or lease *MB BB (Prestel)*

MICRODATA
Dealers for MICRO MATRIX Photo point light-pen for TRS 80 Allows direct interaction between user and program via screen making games such as backgammon faster and also suggesting applications in business and education Package includes pen cassette of 4 programs (including backgammon) instructions and 9V battery £16 99 *PU SB (TRS 80)*

POLAROID
SX 70 instant picture camera for producing hard-copy from V D U s and displays Hood marketed by GDS GRAPHIC DISPLAY SYSTEMS LTD of Cambridge *SB MB*

SPERRY-UNIVAC
UTS 4000 family of communications terminal products including UTS 10 Teletype compatible display to UTS20 editing terminal and UTS 40 user programmable single station Range intended for distributed data processing applications Host support includes S-U Series 1100 System 80 and Series 90 main frames and V77 minicomputers *BB*

TDS TERMINAL DISPLAY SYSEMS LTD
ASCRIBE Arabic Latin Bilingual Terminal designed by INTERNATIONAL COMPUTER SYSTEMS of London only bilingual VDU in the world to both automatically alter Arabic characters to correct start/medial/terminator forms and to automatically position characters for correct left to right or right to left addressing 10 x 16 matrix copes with risers and descenders in Arabic script and increases screen clarity 16 lines of 80 characters on screen 2 extra pages of memory giving total of 48 lines Keyboard engraved in Arabic and Latin texts with 2 or 3 functions per key Z80 based Printer available £1690 *MB BB (Middle East)*

TELEPRINTER EQUIPMENT LTD
Market TELERAY microprocessor controlled VDU terminals in U K 3 basic units in range available in 4 configurations rack mounted metal enclosure and plastic enclosure with either detached or integral keyboard Plug in/snap out I C s and modules for simple user servicing Model 10 offers 24 l x 80c (1920) display with additional 527 character function memory text editing and formatting caps

bility cursor control and position read/write Operator programmable features include aplo communication speeds wide character display 32 control functions and field modifiers (dim blink inverse underline and protect etc) Model 11 has in addition APL/ASCII character set Model 12 is as 10 but with larger 3840 character memory An extra 7500 character function memory allows editing of large volumes of data *MB OEM*

Processor & Memory Boards, Chips, Programmers, Test Instruments, Modules, Training Aids.

BENNETT GUEST LTD
SPARC Simple Processor for Automatic Recognition and Control Designed for use on shop floor in fault diagnosis process control in tank weighing specialist weighing applications general machine control and performance line monitoring etc Displays fault and helps pin-point areas of inefficiency Noise immunity is built into equipment Available with as many inputs or outputs as required 72 hour power-fail memory Software (machine code) provided *Industrial*

BRENTFORD ELECTRIC
Program Editor for process control applications Employs chopper technology and solid state central programming system that avoids operator error and ensures exact repeatability Editor produces process programs which are stored on volatile memory then fitted on power equipment to be controlled Editor is a small portable keyboard complete with buttons and display into which operator enters current/time coordinates as a number of program steps (63 steps provided) A permanent memory can be produced by transferring 1 to a PROM device *Industrial*

CRELLON MICROSYSTEMS
Development module for Z8 single chip microcomputer — Z8 DM single board microcomputer system May be used stand alone or connected to Zilog ZDS or PDS development system Connection to Zilog host D S permits transfer of Z8 software into development module for testing Included are 4Kbytes of 2716 monitor EPROM and 2Kbytes of user RAM Also possible to replace 2K RAM with 2716 EPROM for testing ROM based software Wire wrap area is also provided on which special customer circuits may be accommodated *Systems Designers (Z8)*

TEKTRONIX
7D02 logic analyser aimed at increasing productivity in the hardware/software integration and hardware development phases of microprocessor design Uses a series of personality modules geared to the most popular 8 and 16-bit micro processors Plug-in modules already available provide mnemonic decoding for 8 bit microprocessors including Motorola 6800 and 6802 Intel 8085 and Zilog Z80 as well as 16 bit micros such as Intel 8086 and Zilog Z8002 General-purpose module is available to support other micros and read-only memories are being developed to support other low volume microprocessors with full menemonic decoding 7D02 in a 3 module wide unit in the 7000 Series plug in system and provides 8 channels of timing at 50 MHz and 48 channels of data at 10MHz Up to 56 channels of information can be analysed with 44 channels displayed at once 52 x 256 word memory Versatile triggering and qualification allows a designer to track complex programs or data patterns in a simple programming structure Keyboard layout and menu correspond to high level languages Logic analyser can be triggered by occurrence of a 5NS glitch using 8 channel timing option Separate 8 x 255 word glitch memory allows user to see where glitches occurred 8 channel state display can be decoded into hex octal binary and ASCII formats Self test diagnostics *Engineers Systems Designers*

U-DATA MICRO-DATA SYSTEMS
MP12T Digital Panel Meter Combines 4½ digit liquid crystal display with 12 bit binary data interface Tri state TTL compatible outputs are byte organised enabling it to be used as a direct memory mapped interface to a microprocessor Full VART handshake logic incorporated and a further count serial output enables 2 wire data transmission and high voltage insulation Timing provided by 6 5536 MHz crystal oscillator and band gap reference voltage has a temperature coefficient of 20 p p m Accuracy is 0 025% and sensitivity digitally adjustable between 10 and 500 microvolts per count via the Trescas expansion system Arranged as high impedance voltmeter MP12T can be used to digitise and display any analogue quantity in engineering units £79 plus VAT *Engineers*

Bureaux, Consultancies, Services, Shops

BARIC
Asset Control System a current accounting package designed by accountants for accountants in line with ED24 (Exposure Draft 24) and SSAP 16 Can be interfaced with Baric ledger system Baric Computer Bureau is jointly owned by ICL and Barclays Bank Ltd *Accountants*

BFI ELECTRONICS LTD
High capacity lockable storage boxes for 8 and 5 diskettes ABS with clear acrylic top and non scratch feet pads Dust proof A5 and A6 for 8 and 5¼ disks respectively *PU SB MB*

Xylogics

AT
EUROMICRO 80

Xylogics'latest product allows
advanced 8 inch Winchester
disc drives to be readily utilized
in mini or microcomputer
systems The Xylos provides up
to 40Mbyte disc storage with an
optional built-in 17 Mbyte
cartridge tape, in a 10½ by 19
inch panel space Xylos is
available in two forms, either a
disc sub-system with controller,
for DG Nova, DEC LSI-11 or
Intel Multibus computers, or
with an internal backplane as a
complete LSI-11 or 11/23
computer system
Xylogics are currently shipping
two types of Intel Multibus hard
disc controllers Model 410
controls four 5 + 5 Mbyte
cartridge discs Model 440
handles four 80 or 300 Mbyte
Storage Module Drives,
Winchester or CMD type drives
with an SMD interface

Xylogics

BEYTS LOGIC LTD
Plug in suppressor eliminates mains-borne interference caused by drills heaters and other equipment. Needs no wiring and can handle 1500 Watts at 6 amps and reduces interference between 150kHz and 100mHz Does not suppress radiated interference £19 *PU SB MB*

COMPUTERCLUB
Offers members discounts on hardware software maintenance books publications conferences seminars and exhibitions Newsletter with advice of forthcoming events User Group Reports help advice equipment and software for exchange sale or wanted Annual subscription £7 50 *PU SB Educational*

EBA LTD
(Executive Business Associates) a confidential pool of top businessmen professionals and executives whose expertise is available to clients No charge to client after preliminary discussion members negotiate directly with company concerned Computer related advice currently concerns accounting systems *Accountants*

GSI (UK) LTD
Largest European owned Computer

Services Co has made LOGICA RAPPORT Relational Database Management System available primarily for use by business executives RAPPORT offers relational concept which allows complex data structures to be modelled in a direct straightforward manner simple program interface with easy to use data manipulation language allowing linked retrievals over several fields high performance and full protection of data integrity Interactive access is provided by RAPPORT interactive query language RAPPORT runs on any hardware which supports FORTRAN and direct access disc I/O occupying typically 10K words at run time on a small minicomputer
BB (relational databases)

HAWKER SIDDELEY
Has formed a new software engineering division called DYNAMIC SOFTWARE SERVICES Based near Hatfield DSS will develop and market full range of advanced software systems and packages — including latest real time minicomputer and microprocessor applications — together with essential support and maintenance services for industrial defence and other users in the U K and overseas A recruiting drive is under way to ensure that DSS is in top ten UK software houses within 12 months New facilities include large PDP 11/70 with over 30 terminals Current projects include development in microprocessor control systems for marine automation mining industrial and process control Special emphasis will be placed on applying software disciplines including extensive documentation and design for easy economic maintenance and future support Hawker Siddeley Group sales exceed £1100 million and employees total more than 45 000

MAR-COM SYSTEMS LTD
Offer from new large facilities in Croydon large stocks of magnetic media including Office Data Products 8 floppy disks 5¼ mini disks data cassettes dictation cassettes data cartridges and magnetic cards for use with mini micro computers and word processors Also 3M Scotch data recording products including 8 floppy disks 5¼ mini disks magnetic tape disk cartridges and storage modules Daisy wheels for Qume and Diablo printers and Sony JVC and Bell & Howell audio visual equipment
MB

FCA DATA PROCESSING ACCESSORIES LTD Turn Tables for V D U s makes sharing a painless procedure Several sizes both standard design and pull out keyboard platform models Accepts weights of up to 100 kg Rigid rubber non slip surface Also supplied with centre cable access for greater flexibility *SB MB BB*

Exhibitions, Courses, Events

BARIC
Viewdata management training courses two day workshops designed to give a working introduction to the media and to enable managers to make an informed decision Sept 30 Oct 1 Oct 21 22 Nov 11 12 and Dec 2 3 also one-day seminars for T V retailers to help them sell Prestel T V sets
Managers T V Retailers (Viewdata)

COMMODORE
BASIC for Beginners 3 Day Course starting Sept 2 Nov 4 Dec 2 Advanced Programming in BASIC 3 Day Course Sept 30 Nov 11 Dec 9 Disk Utilization 2 Day Course Oct 9 Nov 20 Dec 18 Service and Maintenance 3 Day Course Oct 6 Nov 17 Dec 15 Cost – £275 £275 £175 £450 plus V A T respectively all held at Skyway Hotel Heathrow Airport also One Day Courses and Seminars held at Park Court Hotel Bayswater London — Microcomputers and the Businessman Sept 9 Oct 14 Nov 25 Word Processing and PET Sept 11 Oct 16 Nov 27 PET in Accounting Sept 12 Oct 17 Nov 28 PET for Monitoring and Control Systems Sept 10 Oct 15 Nov 26 Cost £30 £35 £40 £50 plus V A T respectively *PU SB MB (PET)*

CONTROL DATA
IP12 BASIC Computer Programming Course Broadly follows the syllabus of the Joint National Computing Centre/City and Guilds London Institute '746 BASIC Certificate in Computer Programming includes instruction on data processing concepts IBM COBOL — Theory and Project and RPGII Available at a number of colleges selected commercial training schools and some company in house training centres plus 6 Control Data Institute Centres Approved for MSC s (Man-power Services Commission) new grants for employers scheme

Literature

BRITISH COMPUTER SOCIETY (BCS)
Bibliography to recent literature concerning the Impact of Information Technology on Patterns of Work Produced by BCS Computers and Employment Specialist Group with support from ICL. Prepared by Technology Policy Unit at the University of Aston £3 50 from BCS Employment and Specialist Group

DURHAM COUNTY EDUCATION AUTHORITY
Durham Microcomputer Project Report a document detailing the progress and observations of a close study of the use and suitability of microcomputers in schools over the last 3 years £3 **Educational**

DATA SERVICES
Data Services News the Newsletter of Control Data s bureau division (the largest bureau service in the world) outlines some of the company s activities which include the Cybernet service which provides access to large scale CDC Cyber computer systems in Europe and U S A and Call/Call Plus a business/management time sharing service which runs both CDC and client s software Users currently include companies concerned with petroleum exploration nuclear reactor design radiation safety monitoring structural design and engineering financial analysis accounting and budgeting systems sales statistics planning models automotive design analysis as well as government and nationalised industry **BS**

INDEPENDENT PET USERS GROUP
Newsletter *Europe s first magazine for PET users* Subscription £6 50 **PU (PET)**

PRENTICE-HALL INTERNATIONAL
Catalogue of books on *Minicomputers Microcomputers and Microprocessors*

MICRO-SCOPE
Buying Your First Computer a 90-minute cassette developed jointly with Remma Documentaries Ltd audio visual specialists Based on seminars and lectures given by Micro Scope M D Mr Chris Sealy Assumes no technical knowledge Discusses philosophy of installing a computer how to assess and cost likely benefits and reviews hardware and software as well as peripheral equipment – printers data storage terminals etc Looks at problem of choosing a supplier buying a turnkey system defining requirements Considers bureau vs in-house machine problem Tips on legalities staffing training maintenance security £9 95 inc VAT plus 85p postage & packing **SB, BB**

NCC
Summer book list includes two new volumes – *High Level Languages for Microprocessor Projects* by D Taylor and L Morgan and *"Robots in Industry"* by G L Simons The former brings computer programming experience of last 25 years to people who are being introduced to computing through the development of microprocessor based systems" by describing what a high level language is the benefits they confer and by giving guidance on selection and use of the correct programming language Each language is outlined and illustrated with examples The latter book introduces the industrial robot indicating the various types available and the types of support being offered for robot development and implementation in various countries NCC claim that both books will be of immediate significance for UK managers £15 and £10 respectively

TEXAS INSTRUMENTS
TTL Data Book 876 pages contains comprehensive information on TTL integrated circuits Designed for ease of use with clear indexes and bold margin tabs to identify general circuit categories £6 80 plus £1 p&p Anyone ordering before 17th October will receive a selection of publications from TI s book list free of charge in addition (their publications include MOS memory book (new ed) Linear Control Circuits Data Book 9900 Systems Design Manual and short form brochures on Power Bipolar and Bubble Memories TMS 1000 4 bit microcomputer Censors Optoelectronics Pascal TM990 boards TM990/189 University Boards TL494 Application Report on Switching regulators and data is of microcomputer training courses) **Engineers, Designers (Texas Instruments)**

WABASH TAPE (UK) LTD
Free industry cross reference wall chart for floppy discs Covers 13 industry manufacturers (including IBM Shugart, Verbatim Athana Nashua & BASF) and 22 types of diskette from single side single density to dual side dual density reversible single density and the MRX floppy A user can cross reference 166 separate products at a glance **SB, MB (floppy disc systems)**

ZILOG
Microcomputer Components Data Book 245 pages covers Z80 microprocessor and family of peripherals and Z8000 micro peripherals advanced architecture and Z Bus structure Detailed technical data for each component includes functional description architecture and programming information pin description and electrical specifications **Engineers, Designers (Zilog)**

▶ *Addresses on page 94*

MICROWAVE MODULES LTD

WATCH IT!

THE CONTROL PROGRAM IS CONTAINED IN A USER INTERCHANGEABLE EPROM ALLOWING SOFTWARE MODIFICATION AND UPDATING

COMPLETE TERMINAL
UNIT AND TV INTERFACE
WHICH REQUIRES
ONLY AN AUDIO
SIGNAL FROM
A RECEIVER
TO ENABLE A
LIVE DISPLAY
OF OFF AIR
RTTY AND ASCII
ON A DOMESTIC
UHF TV SET

THE MM2000 COSTS Just £169 inc. VAT
WITH MONEY BACK GUARANTEE
Also available with extra 1K byte of RAM and **HEX** load program in Eprom allowing loading of Kansas City tapes and execution of user programs at
£189 inc. VAT — MM2000M

This unit will enable off air live Radioteletype transmissions to be received and will also read information from tape in several formats including the Kansas City format

A 6802 microprocessor analyses and decodes incoming serial data in Baudot or ASCII at different standard rates. The text is presented as a 64 character by 16 line display under the control of a separate dedicated CRTC microprocessor

MICROWAVE MODULES
BROOKFIELD DRIVE AINTREE LIVERPOOL L9 7AN, ENGLAND
Telephone 051 523 4011 Telex 628608 MICRO G

STCS
S T Commercial Systems Ltd
[illegible]

SuperBrain

COMPLETE twin Z80 CP/M computer system with 64K RAM twin double density disk drives, printer, 2 RS232 ports, integral VDU and BASIC or FORTRAN Plus a full year's guarantee — £2,800+VAT

Printer
MICROLINE 80 by OKIdata the quietest most reliable little printer available 40 80 or 132 characters per line with graphics
Software
Microsoft BASIC or FORTRAN for no extra charge
Guarantee
All hardware fully guaranteed for a year. If anything goes wrong we'll have an engineer at your premises within 24 hours – wherever you are in Britain
SPECIAL Educational and quantity discounts – Dealer enquiries invited
We also stock CP/M software -
Wordstar Selector all Microsoft languages CBASIC and lots more
AND —
TELEVIDEO terminals – call for prices Very special dealer deals

NEC Spinwriters – all models

CALL Maria or Gerry 01-840 1926 anytime 01-992 2909 after hours

ARE COMPUTERS ALIVE?

Technological developments do not proceed in isolation from other social factors. For example, microchip technology is influenced – in its pace of development and in other ways – by current public appetites for entertainment and sophisticated domestic appliances, by the state of the arms race, and by government policies on state investment.

The technology developments, mediated by social factors, in turn influence the character of society, often in unexpected ways. One consequence of computer developments is that we are being forced to scrutinise many traditional ideas about society and people. At the most intimate level we are forced to re-examine what is meant by many of the conventional adjectives traditionally applied to human beings – such words as *conscious*, *intelligent*, *thinking*, *perceptive*, *free* and *aware*. At one level we may even speculate on what it means to be *alive*. There is a consensus that *intelligence*, defined in some way, can be artificial. Can *life* be artificial? In what circumstances would we recognise a computer as alive?

One unreflective response to such an enquiry is to assert that only the recognisable biological species – the plants and animals – are alive, and that *this is a matter of definition*. Artefacts may behave *as if* they were alive, but they are not *really* so. They mimic the behaviour of animate creatures but are themselves *inanimate*.

There are difficulties in this approach. If the semantic decision is taken, on *a priori* grounds, to exclude certain categories as a matter of principle, then linguistic confusion may arise. Consider the case of mobile robots. Suppose it had been said, before the invention of articulated legs, that robots would never *walk*, that *walking* was, by definition, something only done by certain mammals, insects, etc. How would we then describe the behaviour of a biped robot as it progresses across the floor? Surely it *walks*.

This suggests that the limits of language should not be prejudged, that language developed for one purpose (eg, to describe the natural world) may come to be useful for another (eg, to describe artefacts). For example, no one says that only birds, bats and insects can *fly*. Aircraft and kites can fly as well. (But do submarines *swim*? And if not, why not?)

A consequence of this approach is that particular 'biological' words – *conscious*, *aware*, *alive*, etc – may come to describe artefacts. Or they may not. Whether they do will depend upon whether the artefacts in question come to satisfy criteria by which such qualities are recognised. And the formulation of the criteria should be general in the sense that it is independent of the particular fields in which the qualities currently happen to exist. People get angry and machines do not. But the notion of any angry robot is not meaningless or self-contradictory. It should not be presumed that artefacts could never, by definition, experience emotion, or that they could never be alive.

It is interesting to note how 'intelligent' has come to denote certain machine systems. When writers first described such systems (eg, computer terminals with processing capability), they often put the word intelligent in quotes, viz 'intelligent terminals'. Such writers often seemed reluctant to admit that machines could exhibit features that characterise the higher animals. But now such quotation marks are seldom if ever used; there is frequent talk of intelligent peripherals and terminals, machine intelligence, artificial intelligence. The linguistic usage suggests that intelligence, suitably defined, can equally characterise certain biological systems and certain artefacts.

(The response of one layman to the idea of artificial intelligence is nicely described by Margaret Boden in *Artificial Intelligence and Natural Man*: 'In Moscow, attending a conference on artificial intelligence, she encountered a taxi-driver who, on learning the name of the conference, roared with laughter and made the 'crazy sign' against his forehead; nor did he stop doing this, his shoulders shaking, until he had dropped us at our destination some five minutes later.' To such a man there was no question of viewing his passengers with wariness or disdain – 'we offered no threat, just comic relief.')

Before considering the question of whether computers may be regarded as an emergent life-form, it is worth commenting briefly on some mental attributes that have traditionally been regarded as char

Three titanium spar chord and web for a new generation Boeing 767 twinjet airliner are mounted in a Boeing-developed automatic wing spar assembly tool at the company's Everett, Washington plant. They are being automatically assembled to other wing spar structural members. At left is one of the vertical bars which position the spar web at top and bottom locators with clamps hold the spar-chords in position. In the far distance is one of a pair of carriages which move along the track at the bottom carrying sensing and control equipment, drill and drill motor, electromagnetic riveter, fastener feed, and vacuum cleaner to remove metal chips. A manufacturing research engineer is shown on a wheeled work platform developed for use on this tool.

acterising human beings, namely thought, consciousness and free will.

Part of the problem in trying to decide whether computers think is that we are not quite sure what we understand by thinking in general. We assume that human beings think, some more than others – but do animals think? Many of us would maintain that some of the higher animals – dogs, cats, apes, etc – are capable of rudimentary thought, but what about worms and insects? (There is evidence that snails are orgasmic. Electrodes register peaks of electrical activity during copulation which subside after ejaculation. Do snails think about such things?)

Already, technical and popular publications have noted the thought potential in computers. Hence Professor George declared (*Computers and the Year 2000*, 1972) that "the ability to think logically has been shown to be within the capabilities of existing computers." Dr William E Matheson observed (*Personal Computing*, April 1978) that "the machine is closing the gap between itself and the brain." And at the same time, Ernest W Kent was proclaiming (*Byte*, April 1978) that "it may be possible for a computer to have subjective experience."*

A recent 1980 headline, "A Speck that thinks for Itself", advertised work at the University of Warwick and at the Colorado State University ("the superchip machine will be able to – literally – think for itself"). Dr John Barker was quoted: "The working of the superchip will be virtually indistinguishable from the working of the human brain."

One approach is to compare the physics (and chemistry) of activity in the biological brain with activity in the processing units of modern computers. In the computer, sub-atomic particles move in solid material (metal conductors, chips of impure silicon, etc). The chemistry of the silicon and impurities is organised to realise electronic components packed into a small volume. The components operate in concert to perform the logic and arithmetic functions upon which all machine intelligence is based. In the brain, semiconducting properties are also exploited, and pulses of electricity are generated to control the behaviour of neurons (brain cells). The thousands of millions of neurons are interconnected to realise the necessary functions of the organism – from the control of heartbeat and glandular secretion to motor control and all the mental processes of ratiocination and decision-making.

There are obvious similarities between the biological and artificial systems. Both exploit the properties of chemical elements (carbon and silicon, respectively) organised in complex arrays to realise particular analogous functions. It is likely that both types of organisation are physical realisations of theoretical two-state logic systems. Recent research suggests that certain columns of neurons are analogous to computer processors. (In passing, it is interesting to note that silicon has often been mentioned in speculative writing as one possible chemical base for life on other planets. Few elements can support the complex molecules necessary for the metabolic processes in sophisticated lifeforms. However, silicon is used in computers because of its semiconducting properties, not because it can support macromolecules.)

I am sympathetic to efforts to identify thought processes with the physical behaviour of the brain. If the physical behaviour of computer processing units is *sufficiently similar* in important respects to internal brain behaviour, and moreover facilitates *the same sort* of 'intellectual processes – reasoning, decision making, etc – then if the word 'thought' denotes certain brain activities there appears to be no good reason why is should not also denote certain computer processing activities. The key phrases, of course, are sufficiently similar and the same sort. We should not expect identity of, but close resemblance between, the processes and outputs of biological and machine systems.

'A potato in a dark cellar has a certain low cunning about him which serves him in excellent stead.'

It may be objected that thought implies consciousness, that people may be said to be thinking because they are aware of the process. For example, they reason and *know* they are reasoning. This objection can hardly tell against the idea of machine thought. It would be a relatively easy matter to provide additional computer circuits to monitor the activities of the central processor. Would the computer then know that it was thinking? Would it then be conscious? However consciousness is described, it seems difficult to show that its central features could not be provided, albeit at a rudimentary level, by machine facilities.

Another question is that of free will, a supposed characteristic of human beings which distinguishes them from computers. The distinction is illusory. Computers have a choice mechanism by virtue of conditional jump instructions provided in the program. The computer decides what to do according to the prevailing conditions, and very often the decision is unpredictable to the human programmer. If it is argued that this is a tightly deterministic system, uncharacteristic of human beings, then two points should be made: 1) there is a clear sense in which the prevailing conditions that affect computer choice can be unpredictable (ie, non-deterministic in the practical sense) and 2) it would be simple to provide a random (ie, non-deterministic) element in computer decision-making – if there was any point in doing so.

It follows that decision-making, choice and the exercise of free will are synonymous. The corollary is that the decision facility in the computer can serve as an adequate model of free will in the human being. Efforts to preserve the traditional status of free will derive from prescientific notions rather than from careful analysis. In this area, as elsewhere, we can see a close resemblance between machine possibilities and human mental processes.

If we believe that computers can think, be conscious and exercise choice, it does not follow that computers are alive. It is paradoxical, but not self-contradictory, that a thinking conscious entity may not be alive. To show that computers are a newly emerging life form we have to do more than show that they have conscious thoughts and can take decisions.

Samuel Butler (in *Erewhon*, first published in 1872) suggested that machines would develop consciousness ("There is no security against the ultimate development of mechanical consciousness, in the fact of machines possessing little consciousness now.") And he proposed a materialism to show the continuity between the simplest forms of life and man.

After considering possible consciousness in the potato ("even a potato in a dark cellar has a certain low cunning about him which serves him in excellent stead.") he considers what would be the obvious objection to such an idea – ▶

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*See also Professor George's article, Artificial Intelligence and The Layman, in Issue 1.

THE COLD BRAIN

The Josephson junction is a superconducting device based on principles enunciated by the British scientist Brian Josephson in 1962. A superconductor is an alloy or element (for example, tin or lead) which loses all electrical resistance when its temperature is lowered to a few degrees above absolute zero. If a current is then put through a loop of the superconductor, it will flow indefinitely so long as the temperature is maintained. An extremely thin layer of oxide sandwiched between two superconducting slices forms the junction, configurations of which can replace 'conventional' semiconductor devices – at switching speeds measured in picoseconds. The junction consumes very little power, and there is a minimum of noise.

A "cryocomputer" (parts of which have already been constructed) will be very small. One of 15 by 15 by 15 cm dimensions will, on present calculations, be able to support about 16 megabytes of main memory and allow data transfer rates between itself and auxiliary storage of about 2.8 gigabits per second.

Although it is foolish to read too much into an analogy, it still is interesting that this "cold brain" will be immersed in a "brain fluid" of liquid helium. ■

*Acknowledgements to a fine article by Dr Wilhelm Anacker in the May 1979 issue of the IEEE *Spectrum* magazine. A recent article on "cryocomputers" by Juri Matisoo appeared in the May 1980 issue of *Scientific American*. Both authors are at the IBM Thomas J Watson Research Centre in Yorktown, New York, USA – **Editor.**

If it be urged that the action of the potato is chemical and mechanical only and that it is due to the chemical and mechanical effects of light and heat the answer would seem to lie in an inquiry whether *every sensation* is not chemical and mechanical in its operation? *Whether those things which we deem more purely spiritual are anything but disturbances of equilibrium in an infinite series of levers* beginning with those that are too small for microscopic detection and going up to the human arm and the appliances which it makes use of? Whether there be not *a molecular action of thought* whence a dynamical theory of the passions shall be deducible? Whether strictly speaking we should not ask what kind of levers a man is made of rather than what is his temperament?'
(my italics)

(There then follows a quite remarkable suggestion that prefigures the modern knowledge that the nucleus of every biological cell contains genetic material specifying the characteristics of the total organism – he anticipated a time when it would be possible by examining a single hair with a powerful microscope to know whether its owner could be insulted with impunity ')

Butler's willingness to believe in the possibility of machine consciousness ('germs of consciousness will be found in many actions of the higher machines') is also linked to his consideration of machines as an emerging life form At the same time he does not equate life with consciousness (plants are 'without apparent consciousness') He saw nineteenth-century machines as prototypes of future mechanical life , and made an observation which is singularly relevant to modern computer developments – 'The present machines are to the future as the early Saurians to man The largest of them will probably greatly diminish in size a diminution in the size of machines has often attended their development and progress '

I cannot explore in detail Samuel Butler's consideration of machines as an emergent life form (see *Erewhon* Chapters 23 to 25) but some of his ideas will inform what follows It is worth exploring in outline some of the defining attributes of living forms to see to what extent computers share (or could share) such features

A number of the behavioural attributes of living systems are obviously present also in machines Artificial functional devices can for example hear speak respond to bright lights aid their own survival by taking appropriate action in hazardous circumstances and carry out a wide range of creative and intelligent tasks (Robot technology, as one relevant area, is already providing tactile and vision sensors to the point that such facilities as 'eyes' and artificial skin will soon be commonplace elements in factory machines)

Artificial Intelligence

To many people the capacity for reproduction is central to the idea of life The extent to which this ability can feature in machine systems needs to be analysed with care An initial point is that methods of reproduction vary widely throughout the biological world – from simple binary fission in protozoa to all the complexities of sexual reproduction in plants and animals (internal fertilisation external fertilisation larval forms pseudo placental birth, placental birth etc etc) This suggests that the method of reproduction is not the central point The key element is that by whatever means an entity can duplicate itself in a new entity that did not formerly exist We all know that Unimation's PUMA robot is good at performing assembly tasks Suppose it is set to assembling PUMA robots Is it thereby by virtue of its programming, granted a reproductive capacity? Samuel Butler would have said so ('Surely if a machine is able to reproduce another machine systematically, we may say it has a reproductive system)

The objection that man is the effective intermediary in allowing a PUMA to reproduce other PUMAs is not very telling Butler cited the role of insects in plant reproduction – 'Would not whole families of plants die out if their fertilization was not effected by a class of agents utterly foreign to themselves Does anyone say that the red clover has no reproductive system because the humble bee (and the humble bee only) must aid and abet it before it can reproduce?' In this way it can be shown that a robot programmed to assemble robots may be regarded as having a reproductive system

Consider also the functional significance of the genetic material DNA (deoxyribonucleic acid) present in the cell nuclei of plants and animals The genetic material is in part a blueprint a definitive specification for the species (while allowing according to the richness of the gene pool for individual variation) The DNA is a way of remembering what the next generation should look like and how it should behave (so that apes produce baby apes people produce baby people and so on) Now, computers are very good at remembering things and a section of computer store could be allocated to 'genetic memory' – the computer specification could be stacked away somewhere safe possibly duplicated or triplicated for added security so that the computer could retain a constant record of its own identity *The computer could thus be given its own species specific DNA for propagation purposes*

This also relates to the biological life characteristics of *mutation* and *evolution* Because of differences between individuals, biological species have been flexible in evolutionary terms A changing environment favours particular individuals who are thus more likely to generate progeny and so the character of the species changes The mutation feature in part responsible for the individual variation within a species may be regarded as a random element (caused by sunspot activity chemical aberration in DNA duplication pollution in the environment etc)

It would be easy to introduce such a random element into the species specific DNA held in the computer store But it would be highly inefficient and costly to do so A proliferation of unworkable machines would be generated which would have no chance of being selected out by the environment which being well

A Boeing 767 Dr[illegible] tool [illegible] of carriages [illegible] the newly developed B[illegible] spar [illegible]. The carriage and another one much like it on the other s[illegible] spar [illegible] parts of the tool They include sensing and control equipment [illegible] riveter fastener feed and a vacuum cleaner to remove metal [illegible] vacuum chip collector the smaller light colored tube [illegible] to the spar Other tubes are for air supply to the machin[illegible] for the drill Under guidance of the computerized control [illegible] hole location measures the total thickness of the parts [illegible] together drills through the total thickness of the material [illegible] electromagnetic riveters complete the riveting process The carriage [illegible] programmed hole location Total time per rivet is about eight seconds controlled, would be unlikely to change in any way

Another alternative would be to allow the computer 'species-specific DNA' to be modified by input received by sensors For example if the heat or humidity in the environment changed it may be advantageous for the machine reproductive systems to generate different types of machines in the next generation Heat sensors could transmit signals to modify information held in the computer store

Such possibilities though theoretically practical are unlikely to be desirable in any practical environment Nature by being profligate with both biological individuals and species enabled evolution to occur Such profligacy would certainly not be cost effective in the practical world of computers and robots (and would certainly be discouraged by a Thatcher administration)

Other characteristics of biological lifeforms are such things as temperature regulation self-repair of damaged tissue (extending to total limb regeneration in some species) growth and ageing Computers can regulate temperature diagnose faults switch faulty modules out of circuit and organise repair procedures And computers and robots obviously age components wear out and have to be replaced prior to total system replacement In a sense computers can also grow Extra peripherals and additional bits of store can be tacked on, and many systems specifically allow for modular development and expansion

Artificial Intelligence

A key feature of biological life forms is the complex metabolic chemistry the highly complicated procedures that allow animals and plants to digest food generate the necessary substances (enzymes, hormones etc) grow repair tissue and perform all the other bodily tasks that are necessary for development and survival from genesis to death There is no artificial equivalent to the complex metabolic processes that characterise acknowledged living systems Animals and plants achieve their purposes in a way that broadly depends upon rapid biochemical reactions that are too complex to define *in toto* Computers and robots may be organised to achieve similar purposes though at a more rudimentary level, but they will function in a different way without complex metabolic chemistries

> *'A number of the behavioural attitudes of living systems are obviously present in machines.'*

The question as to whether computers are alive can only be answered if we decide what life is *in essence* What are the key characteristics of living systems? If we look for behavioural characteristics – such as obvious intelligence, decision making abilities and the capacity to generate duplicate entities (ie to reproduce) – then artificial systems where appropriately designed may be said to be alive albeit at a very lowly level If, alternatively, we look to the *way* in which animals and plants realise their purpose (ie via a complex dynamic metabolic chemistry) then artificial systems are *not* alive though living artificial systems may be generated in the future

As computers and robots become more able to perform the tasks traditionally characteristic of acknowledged living systems, it is likely that less importance will be attached to the way in which animals and plants realise their purposes In short more attention will be paid to performance and accomplishment and less attention to methods (ie metabolic chemistry will be seen as only one of several ways in which living systems live out their lives) By the time computers and robots are having flexible social intercourse with us playing games, discussing politics and philosophy involving themselves in our concerns, we will incline to view such artificial systems as alive It will scarcely seem important that they do not rely on enzymes and hormones as we do ■

■ *Geoff Simons is the Chief Editor of NCC (National Computing Centre) publications He is the author of* Introducing Microprocessors *(1979)* The Uses of Microprocessors *(1980) and* Robots in Industry *(1980)*

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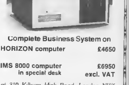

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METHODS AND AN APPLICATION

Dr Fairhurst is at the Electronics Laboratories the University of Kent at Canterbury Readers who have any questions about this article are invited to write to him care of our magazine

In a previous article we examined the whole spectrum of simulation techniques and applications By contrast this article will concentrate on just one aspect of this wide-ranging topic — the simulation of digital systems (and, more specifically logic circuit simulation) in order to illustrate one particular *methodology* of simulation and an important area of *application* Although only one specific application will be considered in detail it is clear that simulation at the level of logical operation of a circuit can be a valuable facility in a number of areas ranging from the testing and verification of prototype hardware designs to the development of software associated with hardware which is non standard or which is itself still under design Let us begin with an overall view of the major features of a logic circuit simulator

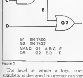


Figure 1

The level at which a logic circuit simulator is designed to operate can vary and the principal elements (the **primitives**) of the simulator are dependent upon the level of operation required If for example the aspect of a system which is of most interest to a designer is the *way* in which information flow occurs in the circuit, then its operation may be simulated by considering [illegible] the [illegible] transfer of data among registers [illegible] any explicit reference to the actual electronic components of the system Such a description of simulation would normally involve the use of a so called Register Transfer Language (RTL)

Alternatively a simulator might have as its basic operational elements or primitives functional components such as adders memory sub systems and so on the purpose of the simulator being to reproduce the *interactions* among these components

A third and very common alternative however, is to model a logic circuit at *gate level* where the simulator primitives correspond to the *actual* logic gates (AND NAND NOR, and so on) themselves A simulation at this level is particularly important for tasks involving the verification of a circuit design or as we shall see later in fault analysis of digital systems and it is this approach which we shall now begin to examine in a little more detail

The circuit to be simulated must first be *described* to the simulator the description conveying information about the components in the circuit and the interconnections among them Various possibilities are apparent and one example of a high level circuit description is to adopt a defining convention for a circuit primitive such as the following

NAND	GX	X Y	Z
type	name	inputs	output

An example circuit and its possible description using this convention is shown in Figure 1 Note that a direct description in terms of a Boolean expression for the logical behaviour of the circuit would often be misleading since the physical structure and topological features would not necessarily be explicit in such a description

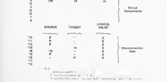
Having described the circuit to be simulated in some appropriate way it is necessary that the specification be *translated* into an *internal representation* in the computer in a format suitable for the execution of the simulation procedure Again this gives rise to a number of alternatives However although the way in which a logic circuit simulator is structured can vary it may usually be identified with one of two general classes being either compiler driven or table driven

In a **compiler-driven** simulator each electronic gate in the circuit is represented by generating a segment of code (perhaps as a subroutine with an appropriate calling procedure) Such a segment of code to represent an AND gate (in an arbitrary language) might for example be as follows

Mnemonic	*Function*
LDA X1	Load the Accumulator with the logical value of input X1
ANA X2	Perform the AND operation between the value of input X2 and the number in the Accumulator
ANA X3	Perform the AND operation between the value of input X3 and the number in the Accumulator
STA Z	Store the *contents* of the Accumulator (the result of AND ing X1 X2 and X3) *in* a location Z corresponding to the gate output

The whole circuit is then simulated by stringing together a list of executable subroutine calls which define every gate in the circuit in the correct order for the representation of the desired gate configuration Any changes in the parameters of the simulated circuit (for example new inputs or initial conditions) require that the host machine re computes the logical operation of every gate in the system by executing every step in the simulation procedure

In the alternative and currently more common approach of the **table-driven** simulator the logical structure of the circuit to be simulated is represented in the form of a number of tables in which are inherent the topological and logical features of the required circuit These tables would in practice of course be represented inside the computer using some standard and convenient data structure such as a linked list and are operated on by a control program which manipulates and updates the stored information and logical values according to the



ADDRESS	GATE TYPE	POINTERS Input pins	POINTERS Output pins	
*1	NAND	*16	15	Circuit Components
2	OR	14	16	
*3				
4				
*5				
*6				
7				
8				

	SOURCE	TARGET	LOGICAL VALUE	
*10	P	–	X	Interconnection Data
*11	P	–	X	
*12	P	–	X	
*13		14	X	
14	*13	–	X	
15	P	–	X	
*16	–	P	X	
*17				
*18				

Note
[illegible]

Figure 2

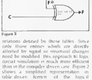


Figure 3

relations defined by those tables. Since only those entries which are directly affected by signal or structural changes need be modified, this approach to logic circuit simulation is much more efficient than in the compiler driven case. Figure 2 shows a simplified representation in table driven format of the logical structure of the circuit of Figure 1.

Fault detection – a case study

As an example of a typical area of application for a logic simulator we will consider briefly a technique for detecting simple faults which might occur in a logic circuit. For the purposes of our example we shall consider a *fault model* which assumes the existence in a circuit of at most one fault at any time, which in its effect causes a single signal line to become stuck at a voltage corresponding either to the logical 0 level or to the logical 1 level. In fact, since most logical faults (such as those caused by short or open circuits) manifest themselves in this way [illegible] assumption is not particularly restrictive.

First we note that, in general, the circuit testing procedure [illegible] we may manipulate and observe directly only those signals which appear on primary terminals — the overall inputs and outputs of the circuit. A second important objective is that we wish to check the circuit without the exhaustive application of every possible set of logical signals on the primary inputs. (Although this would be a theoretically valid testing procedure it is usually not necessary, and may well be prohibitive in terms of the time it requires.) In order to derive an appropriate *minimal* set of input signal patterns (or *tests*) which will allow the complete testing of the circuit, therefore, a number of techniques have been proposed. One such technique is the *fault matrix* method.

The relevance of this technique in the context of simulation is that the first step in its application requires that, through a simulation process, the theoretical operation of the circuit is determined under all possible logical fault conditions. This sequence of simulation runs produces a table called a fault matrix, showing the output of the circuit for every possible test which may be applied and for all fault conditions. For example, for the circuit in Figure 3 a total of ten different possible faults may be identified, corresponding to the following situations:

Signal line A stuck at 0
Signal line A stuck at 1
Signal line B stuck at 0

Signal line F stuck at 1

Test	A	B	C	Fault free f_0	A/0 f_1	A/1 f_2	B/0 f_3	B/1 f_4	C/0 f_5	C/1 f_6	f*/0 f_7	f*/1 f_8	f/0 f_9	f/1 f_{10}
t_0	0	0	0	0	0	1	0	1	0	1	0	1	0	1
t_1	0	0	1	1	1	0	1	0	0	1	1	0	0	1
t_2	0	1	0	1	1	1	0	1	1	0	0	1	0	1
t_3	0	1	1	0	0	0	1	0	1	0	1	0	0	1
t_4	1	0	0	1	0	1	1	1	1	0	0	1	0	1
t_5	1	0	1	0	1	0	0	0	1	0	1	0	0	1
t_6	1	1	0	1	1	1	1	1	1	0	0	1	0	1
t_7	1	1	1	0	0	0	0	0	1	0	1	0	0	1

Note: A/O denotes 'signal line A stuck at O' etc

Figure 4

	f_0f_1	f_0f_2	f_0f_3	f_0f_4	f_0f_5	f_0f_6	f_0f_7	f_0f_8	f_0f_9	f_0f_{10}
t_0	0	1	0	1	0	1	0	1	0	1
t_1	0	1	0	1	1	0	0	1	1	0
t_2	0	0	1	0	0	1	1	0	1	0
t_3	0	0	1	0	1	0	1	0	0	1
t_4	1	0	0	0	0	1	1	0	1	0
t_5	1	0	0	0	1	0	1	0	0	1
t_6	0	0	0	0	0	1	1	0	1	0
t_7	0	0	0	0	1	0	1	0	0	1

Figure 5

With the inclusion of the fault-free case the fault matrix for this circuit therefore contains eleven columns (see Figure 4). The number of rows in the fault matrix is eight, since just eight different logical signal patterns can be applied at the primary inputs of this circuit. The generation of a fault matrix through the simulation of the circuit in this way is at the heart of this fault technique.

The second stage in the process is to compare the column in the fault matrix corresponding to the fault free circuit in turn with each column defining one fault condition. A new matrix (the *difference matrix*) is generated by this process, in which a 0 is written for any pair of entries compared in this way which have the same logical value, and a 1 written for any pair which have a different value. This procedure is illustrated in Figure 5, and it will be seen that the 1 entries in this new matrix now show *where* the existence of a logical fault in the circuit will cause the output of the circuit to differ from its expected value were the fault not present.

The final stage of the fault detection technique is to select the *minimum* number of tests (input signal patterns) which will enable the existence of any of the possible logical faults to be detected. In the example we are following, an inspection of the difference matrix reveals that a suitable combination of tests would be the following:

Test 1 ABC 000
Test 2 ABC 011
Test 3 ABC 100

By applying these three selected test patterns and observing the signal on the primary output a complete logical testing of the circuit may be carried out. The effectiveness of a test selection procedure of this form is clear if it is noted that an exhaustive testing would require the application of eight test patterns to the circuit. Fault matrix analysis has, even in this simple case, reduced the effort required for circuit testing by a significant factor. Although only a relatively brief summary of the fault matrix method of circuit fault detection has been given here it is clear that the existence of a logic circuit simulator is essential for its execution, and our example therefore illustrates a major application area for the simulation techniques outlined earlier.

In this and the previous article we have considered a wide spectrum of simulation techniques and examined a number of applications. Even from this swift guided tour of the subject it should be apparent that simulation can be a most powerful and effective tool for the system designer, not least in that most crucial aspect of his work — establishing or enhancing the reliability of his final design. ■

Editor's note Gil Filbey will in the next issue discuss another simulation and give a FORTH program that implements it.

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MAKING YOUR PROGRAMS READABLE

Bimonthly Series

The fifth article on good programming practices examines how to write a program that users can understand

It is very easy to think that if you follow a series of specific rules when writing programs you will always obtain a perfect program. Unfortunately in the real world things are just not that simple.

It is comparatively easy to write a program which does what it is intended to do most of the time, but it is much more difficult to write a program which will act correctly *all* the time. And it is even more difficult to write a program which not only functions correctly, but behaves sensibly in the event of all data and other user induced errors.

Whereas the programmer will accept curious, and often apparently almost meaningless, system error messages, and may indeed welcome them as giving additional information as to why the program failed, others who do not know it intimately, and who may not even know how to program, will not.

The user will need a specific message which tells him exactly what has gone wrong, and the program should recover to an easily recognised point so that invalid data can be re-entered, and the program run successfully completed. Only if this happens will the user have sufficient confidence in the program to use it.

> *"It may also be that they wished to obscure the operation of the program from unfriendly eyes!"*

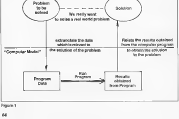
Programs are used to solve Real-world problems
"Real World"
Problem to be solved
Solution
We really want to solve a real world problem
extricate the data which is relevant to the solution of the problem
Relate the results obtained from the computer program to obtain the solution to the problem
"Computer Model"
Program Data
Run Program
Results obtained from Program

Figure 1

The techniques of "Structural Programming" and "Top-Down Design" have been worked out in an environment of large mainframes, on which it is possible to mount highly sophisticated pre-processors and validation programs.

On large software projects it is common to split the design and coding among dozens of analysts and programmers who have to be effectively managed over many months to ensure a coherent final product.

This is a long way from the normal situation with personal computer programs which are written by one or two programmers who have to do all the design and coding work themselves. There is very little management work needed, since so few people are involved. Also even considerably more capable microcomputer systems, such as, for instance the new APPLE III, with their increased memory and input output capacity, will probably not be large enough to allow the use of many of those more sophisticated programming and debugging aids taken for granted by most professional programmers.

The extra capacity is more likely to be used initially to provide some of the facilities which had to be omitted to provide a workable system using the earlier generation of microprocessor. This will include such things as proper *formatting* and *renumbering* facilities in BASIC (and even possibly the *matrix handling* statements which would be very useful in many applications) and a much more sophisticated *disk operating system* than those currently in use. It will also be possible to include some simple *software tools*, the most important being, probably, the ability to obtain *lists* of the variables and program segments used, and detailed *dumps* of the current program status should an execution error occur.

These are not too expensive in storage and execution times, whereas execution profilers which give details of how many times individual statements are executed will still be too large to be practical.

Successful programs

I intend now to outline some of the areas in which some thought should be exercised if your programs are to operate successfully.

It is often said that programs written for personal computers are written very quickly, to solve an immediate problem, and are of little value afterwards. This assumes that your personal computer will be used as a large, and expensive, programmable calculator. Very often, however, programs which were originally written to solve a *specific* problem are later modified to form the basis of a much more *general* package. If the original program is designed with care its full potential can be recognised and *realised* with a minimum of effort.

Here are some ideas as to how to design your programs so as to maximise their usefulness.

- *Data structures should represent the situation in the real world, which the program is expected to represent.*

The data required by a program is extracted from the real world so that we can use the computer to help us to solve real problems (see figure 1). We must be careful to ensure that the representation of that data within the program is as close as possible to the situation in the real world.

If we wish to have as options the colours red, yellow and blue, we should declare a variable which can take these values rather than an integer into which we must encode the data we require. Otherwise there is ample opportunity for coding errors, and also illegal codes, which can have disastrous results, which are not at all easy to trace.

Proper *string-handling* facilities are essential, since even if the program is intended to perform a complex "number crunching" task, it will still have to read in data and print out results. If these operations can be done in the most natural way the opportunity for errors will be greatly diminished.

There is no reason why a program should not make *reasonable assumptions* about what you wish to input, and use these unless you tell it otherwise. In some applications this can give tremendous savings in time by avoiding the necessity of entering the same data over and over again.

- *Use variable names which are meaningful*

The most important aid to understanding how a program functions is to use readily *understandable* variable and other names. For instance, if we use the name "velocity", it is immediately recognisable wherever it is used, whereas the single letter "V", or some meaningless combination of characters, such as "Q9", is not. The reader is given the extra job of deciphering the user defined names used, as well as working out the structure of the program.

His job is made still more difficult, and the possibility of programming errors greatly increased, if variables are used for more than one purpose within the program. Unless store is very restricted this is totally unnecessary and can only cause confusion.

- *Check all input data*

Input data should be *checked* to see whether it is valid for the application being programmed. If it is not the user should be told immediately, and the program should ask for the data to be re-entered. If particular combinations of data are likely to cause problems later (by, for instance, making the program attempt to divide by zero and so cause an arithmetic overflow) they should be checked for at the earliest possible stage, and the user should be asked to re-input the offending data.

One should not rely on (non-specific) system error messages. A message from the program saying a given combination of data is meaningless is far more useful than a general system error message, which may require considerable interpretation before it can be understood.

The program should also ask for *confirmation* before it obeys any command which has catastrophic and irretrievable effects, such as deleting all data files. This avoids the possibility of mistyping causing

total disasters, and if the checks are designed with care, should not be burdensome to the user.

- *Avoid unnecessarily obtuse program control structures*

If you follow the rules of structured programming *unthinkingly*, it is very easy to find yourself writing incredibly obtuse program structures. One of the worst is the nested if clause generating something like:

```
if <condition> then
  if <another condition> then
    if <yet another condition> then

    else

  else

else

```

or even worse

```
if (condition) then



else
  if (another condition) then


  else
```

which, although structurally valid in any real programming situation, is almost unreadable.

This should be avoided, if possible, since if a program is difficult to understand, it is more likely that you will make errors in its logic. Also, should it require modification at some later date, it will not be obvious what the total effect of any new code on the whole program will be.

- *Lay your program out in such a way that it shows the structure of the program*

Even if a program has been designed with care, the overall structure may be lost by careless layout of the source text. Most large computer installations have special *program formatting* programs which are very valuable in that they give a standard layout which is easier to understand, because it is familiar. Only the largest microcomputers are, at present, powerful enough to provide this facility.

However, as long as a reasonable set of layout rules is applied, very acceptable program texts can be produced. Some of the most modern editors, for instance the UCSD PASCAL system EDITOR, have special facilities, such as auto indention, which are specifically designed to allow you to do this easily.

- *Keep things simple*

In the early days of computers, programmers took great delight in designing their own methods of programming simple tasks. These would save a byte or two of store, or execute a millisecond or so faster than the more conventional method. The problem was that it was probably unintelligible to anyone except the programmer himself.

This was fine so long as the programmer was around to look after his program. But if he was not, and then should any problem occur, large sections would probably have to be recoded to clear it.

A little of this mentality has been shown by microcomputer programmers recently, when they use very obtuse data representations for simple items to apparently save a very little time or space. It may also be that they wished to obscure the operation of the program from unfriendly eyes! With a certain amount of rewriting, the text of the program can be greatly reduced, and its operation made much clearer by the removal of several irritating 'features' of user interface. It is then a much more satisfactory program, which performs more than adequately, and is much easier to update.

Will programmers join the dole queue?

There is at present considerable concern over what is thought of as the 'de-skilling' of programming, for with the general adoption of sensible high-level languages, anyone can write programs which work. This, of course, causes concern to programmers in that their monopoly is disappearing.

With the sudden growth of small systems, there is no longer the traditional situation of several programmers for one machine. Quite the reverse – there are now many machines to every professional programmer. It is obvious that the more foresighted manufacturers have recognised this, and are now introducing new machines which one can operate with a minimum of computer knowledge.

This does not mean, however, that programming as a profession is dying. We can all write, but there are very few successful novelists. Every microcomputer owner should have the facility to write programs, but most will normally purchase packages to perform the main functions they intend to use their systems for.

The professional programmer will therefore be required to produce *standard* products which can be *configured* to meet a wide variety of requirements on a whole range of different hardware. He will have to take great care over his design of the user interface which is becoming more and more important as users become much more inexperienced than before. ■

Iverson's Language

Reduction, Selection and Tabular Data

The first article in this series appeared in Issue 6

REDUCTION MAXIMUM, MINIMUM, AND SUM OF A LIST

Consider a vector such as

```
      SALES←3 1 9 15 12
```

where each component is the sales figure for a branch office Clearly the total sales are given by adding these together Now combining the elements of a vector in some way – especially addition – is a common requirement as you probably appreciate APL deals with this with a primitive termed reduction The reason for the name is that it reduces a vector to a scalar Enter

```
         +/SALES
   40
```

The separate terms are summed

There are two symbols here "/" and "+" The / sign called "slash" or reduction indicates reduction, whilst the + indicates the mode of reduction

Enter the following

```
        ⌈/SALES
  15
        ⌊/SALES
  1
        ×/SALES
  4860
```

Clearly, 15 is the maximum term in SALES 1 is the minimum, and 4860 is the product of the terms

Why is this so?

Well reduction effectively puts the scalar primitive on the left between each term of the argument so that +/SALES is a quick way of writing

```
  3+1+9+15+12
```

⌈/SALES is a quick way of writing

```
  3⌈1⌈9⌈15⌈12
```

Evaluate from right to left:

```
        15⌈12
  15
        9⌈15
  15
        1⌈15
  15
        3⌈15
  15
```

In these examples, the scalar primitives are commutative – ie it doesn't matter which is the left argument and which is the right You must be careful in the case of noncommutative operators like - and ÷ Eg

```
        -/SALES
  8
```

To see this recall that -/SALES is an equivalent way of entering

```
  3-1-9-15-12
```

Evaluate from right to left

```
        15-12
  3
        9-3
  6
        1-6
  ¯5
        3-¯5
  8
```

[Minus reduction gives an alternating sum In ordinary notation, it is

3 − 1 + 9 − 15 + 12]

EXERCISE

1 The heights of 10 men, in inches, are as follows

```
HEIGHT←78 77 67 79 66 67 68 72 69 74
```

What is their average height?

2 There are now 10 classes of men with the following numbers in each class

```
      CLASSN
7 2 4 13 19 11 6 16 2 20
```

How many men are there altogether?

If the heights in question 1 are associated with each class what is the average ▶

```
APL:     ⌈ × A-Z ⌊  IN CONJUNCTION WITH REDUCTION,⌈ AND ⌊ MUST
ASCII:   S # a-z D  BE TYPED AS  S  IN ASCII MODE
```

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height now?

[For class data the average is given by

$$\frac{(\text{no in class1} \times \text{height1})\ (\text{no in class2} \times \text{height2})}{\text{Total no in all classes}}$$]

3 In CLASSN what is the largest class? What is the smallest?

4 Write an expression for the difference in height between the largest and smallest man

SELECTION

Very often we wish to select a subset from a vector such that each element chosen satisfies a certain condition such as older than 25 years earns more than £5 000 p a , etc This is achieved in APL using reduction with the left argument a logical vector defining the items chosen rather than a scalar dyadic operator Enter

```
      1 1 0 0 1 0/1 2 3 4 5 6
1 2 5
      1 1 0 0 1 0/'HIDE!*'
HI!
```

The left argument which is a logical vector of the same length as the right argument has selected from the right argument according to the criterion

- *select if corresponding left element is 1
- *reject if corresponding left element is 0

This is termed compression because it transforms a vector into a smaller vector A practical example follows

The following is a list of employees income (£) over the past year

```
INCOME←6300 4700 5750 7500 4850 9800 4800
```

List the incomes exceeding £5 000 p a

Recall the relational operators listed in article 5 and enter

```
      MASK←INCOME>5000
      MASK
 1 0 1 1 0 1 0
```

Now enter

```
      MASK/INCOME
 6300 5750 7500 9800
```

which is precisely what is required

We called the logical vector MASK because it is sometimes thought of as a kind of mask, masking the objects we don't want with a 0

The rules for compression are simple

- *In A/B A must comprise only 1 s and 0 s
- *If B is a vector A must be a vector of the same length as B or a scalar (in which case it is of course a single 1 or 0)

We haven't covered the case of the left argument being a single element it is very simple

- *If the left argument is 1 the result is the right argument
- *If the left argument is 0 the result is the null vector

To illustrate

```
      1/'INCLUDE'
INCLUDE
      0/'INCLUDE'
```

(APL returns a blank line – the null vector)

This is of course similar to the conformability rule for scalar dyadic functions – if there is a single 1 or 0 the left argument extends itself to be the same length as the right argument

EXERCISE

1 Enter

```
      RAND←? 20⍴5
```

Check ⍴RAND (should be 20) and display RAND – it is a 20 element vector containing the digits 1 5

Find a logical vector E, which gives the positions of all members = 3

What will E/RAND give?

How do we find how many 3 s occur?

2 Enter the following character vector

```
MSG←'ZSEZZCZREZTZZZNZZOZTTEZ'
```

Check that ⍴MSG is 23

What does (MSG≠ Z)/MSG give?

How many Z s in MSG?

LOGICAL FUNCTIONS

We have seen that there is an elegant way of selecting those elements from a list with a given property We can write this symbolically as

condition/list

Where condition is (list>0) or (list = x) etc

We now introduce the logical functions These enable the "condition part to be considerably extended for example we may wish to pick out members of a list satisfying two properties, such as <50 and >20

OR

Enter

```
      1 0 1 0 ∨ 1 0 0 1
 1 0 1 1
```

This is called "logical or" It returns 1 (true) if at least one of the arguments is 1 To see why it is called "or , consider the following example

Children are allowed into a certain school if they are at least 11 years old or if they achieve more than 70% in an entrance exam A list of candidates have ages A and attain marks, M, as follows.

```
A← [illegible]
M← [illegible]
```

The candidates C are identified by the letters A-K as follows

```
      C←'ABCDEFGHIJK'
```

which candidates are suitable?

Consider

```
      A>11
 0 1 0 0 1 0 1 0 0 1 1
      M>70
 1 1 0 1 1 0 0 0 1 0 1
```

Suitable candidates are those with at least one "1" which is given precisely by

```
      OK←(A>11)∨M>70
      OK
 1 1 0 1 1 0 1 0 1 1 1
```

(Why are the parentheses necessary around A>11 '?)

The candidates are selected by

```
      OK/C
ABDEGIJK
```

AND

The function and has the following pattern

```
      1 0 1 0 ∧ 1 0 0 1
 1 0 0 0
```

i e only if both elements are 1 is the result 1

To illustrate and' suppose in the above example that we demand that an entrant must be older than 11 years and achieve more than 70%

Consider

```
      (A>11)∧M>70
 0 1 0 0 1 0 0 0 0 0 1
```

and the successful candidates are, of course

```
      ((A>11)∧M>70)/C
BEK
```

```
APL:      ⌈ -
ASCII:    S ‘(grave)
```

```
APL:      ← × A-Z
ASCII:    _ # a-z
```

```
APL:      ←A-Z
ASCII:    _a-z
```

You should study the use of parentheses in this example If in doubt remember that you may solve it in stages as follows

```
          ACK←A>11
          MCK←M>70
          CK←ACK∧MCK
          CK/C
    BEK
```

NEGATION

The monadic function "not" is used to transform 0 1 into 1, 0 respectively

To illustrate "not", we give two examples

Using the variables defined above, the candidates with marks≤70 are selected by

```
      ~M>70
  0 0 1 0 0 1 1 1 0 1 0
```

A more difficult example the unsuccessful candidates are given by

```
      (~(A>11)∧M>70)/C
 ACDFGHIJ
```

(Do this by stages if you wish)

APL Series

EXERCISE

1 A database has the following personnel records

```
      AGE
36 42 42 32 48 39 47 21 33 46 31 36 37
      SEX
F M M F . .
      STATUS
M S M S S S . .
      SALARY
4940 3740 . . .
      EXP
9 3 6 11 . . .
```

Denoting the personnel by the numbers 1-20, select the following

(a) all personnel older than 40

(b) all married women (ie SEX = 'F' and STATUS = 'M')

(c) personnel between ages 25-35 with more than 10 years experience (EXP>10)

(d) all except single men earning less than £4 000 p a

(e) are there any single women younger than 27 years old earning more than £4,500 with less than 5 years experience?

((d) and (e) are expecially difficult: do them in stages)

EXERCISE

1 Construct the vector

```
V←?10⍴20
```

Using "or reduction" check whether 15 occurs in V

2 Find the average of V

3 Enter two vectors

```
A←?5⍴15
B←?5⍴15
```

(a) construct a vector, HI, containing the larger of corresponding elements of A and B,

(b) construct a vector LO containing the smaller of corresponding elements of A and B,

(c) form the vectors C←A, B and HILO← HI, LO.

(d) check that the sum of C equals the sum of HILO

Why is this so?

(e) Enter

```
+/(HI-LO)=B-A
```

explain the result ■

To be continued

```
APL:      ⍴ dyadic ⍴ monadic A-Z      APL:     ∨ ←      APL:      ←
ASCII:    reshape  shape     a-z      ASCII:   & _      ASCII:    _
```

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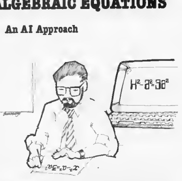
SOLVING ALGEBRAIC EQUATIONS

An AI Approach

The author explains some of the approaches of workers in Artificial Intelligence to the problem of writing a program to solve algebraic equations. In his previous two articles (Issues 8 & 9) he introduced the AI language PROLOG and gave a practical example of its use.



In this article I hope to introduce the reader to some of the ideas which workers in Artificial Intelligence employ when trying to deal with a potentially explosive domain. The general idea is that of a domain where there are so many possible ways in which a computation could conceivably continue from any given state that some method must be found of curtailing and restricting choice of what to do next within the computation.

There are many such domains, and we shall be looking at the domain of algebraic manipulation, and in particular at how we might go about solving symbolic algebraic equations such as the reader might remember from schooldays. Another good example of an explosive domain is that of the game of chess, where there are an immense number of possible games that may legally be played, but where there is usually at the most only a handful of *good* or even *reasonable* moves from any given position. In ways that are not at all yet fully understood, the human chess player is able to discard most of the *possible* legal moves and concentrate his efforts on exploring a few moves which look worthwhile to him.

Similarly, the human mathematician is able to manipulate a given algebraic equation in such a way that he ignores most of the ways in which he *could* manipulate it, and uses his prior knowledge and experience of solving equations to guide him in manipulating the equation in such a way that he moves closer to its solution.

Within a given domain, such as chess or algebraic manipulation, much work in Artificial Intelligence is devoted to finding out just what this specialised expert knowledge is which guides the search so efficiently, and further, how it might then be programmed on a computer.

The Combinatorial Explosion

The main problem which arises when writing a program to solve algebraic equations, as in many other domains of Artificial Intelligence work, is that of the *combinatorial explosion*. By the rules of algebra there are infinitely many ways in which a given equation may be transformed into an equivalent equation. For example the equation $2x = 4$ may quite legally be transformed into the equivalent equation $4x = 8$ by multiplying each side of the equation by 2. It is obvious to us that this is a spurious thing to do in this case, since it takes us no nearer to the solution of the equation, but there might very well be occasions when multiplying each side of an equation by 2 is a very useful move to make, for example, if solving the equation $x/2 = 3$. The problem is then to write a program which *selectively* applies the many rules of algebraic manipulation to the equations input to it, at each stage of the computation choosing the next rule to apply in an intelligent way. Then the program doesn't have to try exhaustively every possible way of manipulating an equation, and the combinatorial explosion is avoided.

In the game of chess let us say that, on average, there are 20 possible moves for a player to choose from at each turn. Then to look just 4 moves ahead would in theory mean looking at 160 000 possible continuations. Any computer program working on this exhaustive search principle would quickly run out of time. In equation-solving the situation is even worse, since with an *infinite* number of possible ways to transform an equation, an exhaustive search of even all possible single transformations is impossible. (There are in theory an infinite number of ways of transforming an equation, since one can, for example, add any integer to both sides of an equation without altering the value of its solution.)

How do human mathematicians overcome this problem? From what we have learned so far, it seems that for certain types of equations they are able to recognize special features of each type and then to act on this knowledge and to transform the equation in hand in a way which takes them nearer to the solution. Such knowledge of what features to look for in an equation, and then of what to do when these features are recognised, is called *strategic knowledge*, and the efficient programming of this type of knowledge is what makes an effective equation solving program.

Some Strategies

Consider the equation

$$x^2 - a^2 = 3a^2$$

What we notice straight away is that there is only one occurrence of the variable x in the equation, and acting on this feature of the equation we can proceed to *isolate* this occurrence of x that is to progressively transform the equation to an equivalent one of the form x = S where S is an expression not containing x This strategy of *isolation* transforms the equation thus

(1) $x^2 - a^2 = 3a^2$
(2) $x^2 = 3a^2 + a^2 = 4a^2$ **(add a^2 to each side)**
(3) $x = \sqrt{4a^2} = \pm 2a$ **(square root of each side)**

We see that each transformation of the equation consists of stripping away something from the left hand side In going from (1) to (2) we used the general rule

$$U - V = W \rightarrow U = W + V$$

with U taking the value x^2 V taking the value a^2 and W the value $3a^2$

This rule states that if you have an equation of the form U V = W then it is legal to transform it to the equivalent equation U = W + V In general this may or may not be a useful thing to do but if there is only one occurrence of the variable in the equation, and moveover if this occurrence is within U then we can say that it *is* a useful thing to do since it takes us one step nearer to the desired equivalent equation of the form x = S

To go from (2) to (3) above we use the general rule

$$U^2 = V \rightarrow U = \pm\sqrt{V}$$

with U taking the value x and V taking the value $4a^2$

Having applied this rule we are left with the equation x = ± 2a, which is the desired solution

So we program the strategy of *isolation* by marking which rules of algebraic manipulation might be useful to it Then when we are faced with an equation with just a single occurrence of the variable within it the strategy of isolation is invoked which then transforms the equation by trying to apply *only* those rules marked useful to it Indeed in this case only *one* such rule will be applicable at each stage and so the computation is deterministic and the combinatorial explosion is overcome

Further examples of rules of equation transformation which are useful for the isolation strategy are

$\sin(U) = V \rightarrow U = \arcsin(V)$
$U \cdot V = W \rightarrow U = W/V$ **('·' denoting multiplication)**

What can be done when there is more than one occurrence of the variable in an equation? Let us consider the equation

$$2 \cdot x + 3 \cdot x = 10$$

Here the human mathematician would 'collect terms (the terms being 2 x and 3 x) to give the new equation

$$5 \cdot x = 10$$

This new form of the equation then has only one occurrence of the variable x and is thus ripe for the isolation strategy described above

What has happened is that we have applied the rule

$$U \cdot W + V \cdot W \rightarrow (U + V) \cdot W$$

to the left hand side of the equation with U taking the value 2 V taking the value 3 and W taking the value X There are many such rules as the one just used each of which may be used to reduce the number of occurrences of some term within the equation The strategy which recognises when to apply such rules and then selectively applies one of them is known as *collection* Other examples of transformation rules which may be used by the *collection* strategy are

$(U + V) \cdot (U - V) \rightarrow U^2 - V^2$ **(collects both U and V)**
$(U \uparrow V) \cdot (U \uparrow W) \rightarrow U \uparrow (V + W)$ **(collects U)**

where '↑' denotes exponentiation

The collection strategy gives us a powerful tool for reducing the number of occurrences of a variable within an equation ideally to the point where there remains just one occurrence at which stage the isolation strategy may be called In general, however we often find that two occurrences of a variable are not close enough together within an equation for any of the collection rules to be applied In this case we need a strategy which will bring such occurrences closer together without altering the value of the equation This strategy we will call *attraction* and some examples of transformation rule which are used by this attraction strategy are

$U \cdot V + U \cdot W \rightarrow U \cdot (V + W)$ **(attracts V and W)**
$\log_W U + \log_W V \rightarrow \log_W (U \cdot V)$ **(attracts U and V)**

A Worked Example

To illustrate the application of the strategies described above let us consider the equation

$$\log_e (x + 1) + \log_e (x - 1) = 3$$

First of all we can apply the second attraction rule above to the left hand side to yield

$$\log_e ((x + 1) \cdot (x - 1)) = 3$$

with U taking the value x + 1 V taking the value x - 1 and W the value e

Now the program can apply the first of the collection rules given above to yield

$$\log_e (x^2 - 1) = 3$$

with U taking the value x and V the value 1

Now the equation has only one occurrence of the variable x and by successive applications isolation rules yield

$$x^2 - 1 = e^3$$
$$x^2 = e^3 + 1$$
$$x = \pm\sqrt{e^3 + 1}$$

This is the desired solution although the negative solution must be discarded since the term $\log_e (x - 1)$ in the original equation is undefined for $x = -\sqrt{e^3 + 1}$

Implementation in PROLOG

At the Department of Artificial Intelligence at Edinburgh University a working program called PRESS (*PRolog Equation Solving System*) has been implemented in the language PROLOG which incorporates all the above strategies In addition it has other strategies such as the ability to change the unknown within an equation to yield a simpler equation For example it will recognize that the equation

$$5^{2 \cdot y} - 5^{y+1} + 6 = 0$$

is in fact a quadratic equation in 5^y and thus by changing the unknown to $x = 5^y$ it produces the much simpler equation

$$x^2 - 5x + 6 = 0$$

The program is being developed further and an exciting new venture is to enable it to learn new strategies of equation solving for itself thus enhancing its own power

Possible Developments

Powerful algebraic manipulation programs are already of great use to scientists and engineers, facilitating speedier and more accurate processing of mathematical formulae and equations than by traditional pen and paper methods The computer has also proved its worth in tackling problems of symbolic differentiation and integration within the calculus In future I think that we shall see more of these non numerical applications of the computer's power and problems which at present require a skilful mathematician to find their solutions will be handled either routinely by computers or by a combination of mathematician and computer working together interactively

More generally the construction of commercially and industrially useful expert computer systems is just starting to really take off and the lessons learned by AI researchers when writing expert programs such as PRESS will soon be bearing fruit ■

● *Bob Welham is previously of the Department of Artificial Intelligence Edinburgh University He is now an independent consultant with a particular interest in artificial intelligence*

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HANDLING DATA

Part II: Indexed Files

In the previous article of this series I described how sequential files are structured and processed The main disadvantage of sequential files is that if you are looking for a record with a specified key you have to read each record in turn before getting to the one you are looking for Now In some situations this is not a disadvantage, however, when a rapid response is needed this form of file organisation becomes much less attractive

Consider a file of records, held by a credit card company, which is organised sequentially (see below) Fig 1

This file consists of a collection of records Each record contains a *unique* card number, the name of the holder, the amount of money that the holder is allowed to be in debt and the current balance of money owed This file is ordered on the card number field

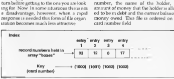


Figure 2

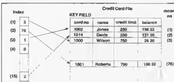
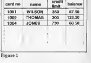


Figure 3

A customer arrives at a shop wishing to buy an expensive article He wants to use his credit card Since the sum involved is large, the proprietor of the shop has to check that the customer has enough credit to buy the article He phones the credit card company who *search* the credit card file

Assume the customer's credit card number is 9073 This will mean that perhaps eight or nine thousand records have to be searched This may take many minutes, and one would hardly blame the customer if he changed his credit card to one belonging to a company with a much more rapid response to queries



Credit Card File

card no	name	credit limit	balance
1001	WILSON	350	67.50
1002	THOMAS	200	122.20
1004	JONES	730	60 56

Figure 1

When a sequential file is searched some queries will retrieve records near the beginning of the file, others will retrieve records at the end of a file On average a query on a sequential file will involve looking at n/2 records where n is the number of records in a file In real life credit card companies have files with hundreds of thousands of records so you can see that a customer's wait could be considerable There is obviously a need for a file organisation that permits a *rapid response* to queries

Series

In order to achieve a rapid response files that are going to be accessed must be stored on what is known as **direct access** storage units These units typically moving head disc units or floppy disc units have the property that a record can be accessed directly *without reading other records* in the file In order to characterise this properly the algorithm that I use in this and the next article will use the instruction

Read direct (n,a)

which will read the nth record in a file and put it into a variable called a

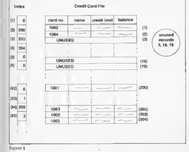


Figure 4

I shall also use the instruction

Readnext (a)

which will read the record after the record that was previously read Thus

Read direct (12 b)
Readnext (c)

will put the 12th record in a file into variable b and the 13th record into c

To accomplish a rapid response we need to associate a key value with the record number of the record to be retrieved This article will examine how **indexes** enable that association to be made

An index works in the same way that an index at the back of a book works If you were reading a travel book on Europe and you wanted to know something about Vienna, then you could do one of two things Firstly, you would scan the book page by page until you see Vienna mentioned this is equivalent to searching a file sequentially Secondly you could turn to the *index* at the back of the book This index has a series of entries organised in alphabetical order, each entry being *associated with* a page number Once Vienna has been found in the index you can turn to that page number *directly*

How can an index help us with the credit card problem? In order to simplify the problem a little, let us assume that a credit card number can range between the values of 1000 and 9999 We shall also assume that some credit card numbers are unused, waiting for a customer to be assigned to them An index can be constructed, the first entry of which contains the record number of the record with a key of 1000 etc Any card number which is *unallocated* would have its index entry set to zero (See Figure 2)

(The key opens the 'box Inside the box is a note which points you to the record number in the file Once the record number is known the record can be examined)

In the diagram above the record with the key of 1001 has a record number of 12 while the record with a key of 1002 is unallocated If the index is held as an *array* in memory and if we refer to this array as **index** then the record no corresponding to a key k is held in (contained inside)

index [k - 999]

Thus the entry for key 1003 is held in

index[4]

The algorithm for retrieving a record with a key k is

```
record no  = index [k - 999]
if record no = 0  then
   print a message saying that the account
   number is unallocated
else
   read direct (record no  rec)
```

The record retrieved is put into *rec* Since the index is held in memory, the retrieval of the record number is *rapid* the record number extracted being used to directly retrieve the record required

An important point to notice is that there is *no need* for the credit card file to be ordered on the card number This is shown in the diagram Figure 3

(Let s do it 'by hand' Look at the diagram Take for instance credit card number 1014 Now take away 999 i 1014 999 = 15 Look at the fifteenth entry in the *index array* The 'box contains 2 So record number 2 is the one we want. Now we can read it completely We

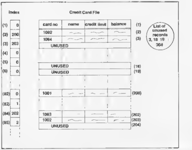


Figure 5

didn't need to order the file on the credit card number)

If there is a requirement to process the credit card file sequentially e g we may want to print out the card holders in ascending order of card number then this can be done by accessing the index itself sequentially Try it for the first two or three "boxes" of the index

The file, where for every record in the file there is an entry in the index corresponding to that record, is known as a **fully indexed** file

The insertion and deletion of records in a fully indexed file is fairly straight forward The best way of carrying out this operation is as follows:

- Make the file large enough to hold every possible record that can occur In the credit card example where card numbers vary from 1000 to 9999 the credit card file is set to contain 9000 records
- Keep a *list* of the record nos of those records which are not allocated to a card holder

This is the diagram Figure 4

Records numbered 3, 18 and 19 are unused

The following actions are taken when a record is deleted or inserted

Deletion

- When a credit card holder ceases to hold a card
- Mark his record as being unused and
- Place the record number into the correction of unused records

Thus, if the card holder who holds the card numbered 1003 returns his card then index [4] (103 - 999 = 4) is set to zero record number 204 (previous content of index [4]) is marked as unused and 204 *added* to the list of unused records This is shown in Figure 5

Insertion

When an applicant is given a credit card

- The index is searched for an entry equal to zero
- The card number corresponding to that entry is assigned to his card (in the above diagram this is Index 1, 999 + 1 = 1000 so this would be the card number 1000)
- Next, an unused record is extracted from the *list of unused records* and the card number, name of the holder credit limit and a balance of zero pounds inserted into this record In Figure 5 the first unused record will be record number 3
- Finally (in this instance) an index entry for card number 1000 is given the value 3 and the number 3 is *removed* from the list of unused records

This is reflected in Figure 6.

The major assumption that I have made is that the fully indexed file is small enough for its index to be held in main storage Often this is not the case and the index *itself* has to be held in a file Thus makes no difference to my description of this method of file organisation The only difference is that consulting the index is a lot slower since it, itself is held in a file

Series

Indexed sequential files

The use of an index which has an entry for each record in a main file can use up a lot of space

An alternative form of organisation uses a form of index that occupies less space It is known as an **indexed sequential** file

In this form of organisation the *main* file is ordered sequentially on its key In the credit card file this would be the card no field The main file is partitioned into sets each of *n* records For each set there is an index entry which gives the *highest* key value in that set together with its record number of the *first* record in the set

Thus if the credit card file is partitioned into sets of 5 records the index will be constructed as shown in Figure 7

The size of the index has been *reduced* by a factor of five However searching for a specific record will take a little *more* time To find a record corresponding to a key

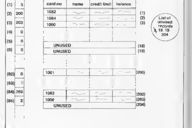


Figure 6

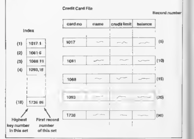


Figure 7

involves searching the index looking for the first key greater than the one being searched for The diagram Figure 8 shows the search for a record with the key 1071

Entry 2 in the index contains the key greater than 1071 We now know that the record with key equal to 1071 *lies between* record 6 and record 10 in the credit card file We can now search the credit card file

from record 6 to record 10 reading each record sequentially You can see that an indexed sequential file enables the position of a record to be retrieved to be estimated A short sequential search is then used to retrieve the record

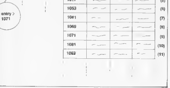


Figure 8

The example given has one *level* of indexes There is however no reason why there shouldn't be *another index* which enables the index in the above diagram to be searched more efficiently In a data processing (dp) environment where a main file such as the credit card file is large it is common to find many level of indexes an index to an index to an index to an index to a main file!

Deletion and insertion of records provide indexed sequential files with a few more problems than fully indexed files

Deletion is achieved in IBM's indexed sequential organisation by placing a pattern of binary 1s in the first byte of a record The index sometimes has to be modified too For example, if the record 1081 in the above diagram is deleted index [2] has to be changed to contain (1071,5) You can see that deletion does not get rid of a record from a file If a new credit card number of 1053 is allocated this deleted record can be used again

Insertion of a record is handled in a number of ways The popular way is to associate space for extra records in each set corresponding to an index entry these records are filled when an insertion takes place The space for new records is often referred to as an *overflow* area When the overflow areas in an indexed sequential file are used up then the file has to be reconstructed with new overflow areas ■

- *To be continued*

Dr Darrel Ince is at the Faculty of Mathematics the Open University Milton Keynes

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SERIES

Part III: Ultrastable Systems

Previous articles in this series appeared in [illegible] issues [illegible] of our magazine

It may help if I recapitulate some of the main points discussed in this series so far. These are

- a business system as an 'open system' strives to maintain its steady state or dynamic equilibrium as opposed to static equilibrium because of its capacity for self regulation
- a business system is probabalistic as opposed to deterministic because of the uncertainty which faces it all the time
- a business system is embedded in its environment. This is changing continuously their interaction gives rise to great complexity

These main cybernetic characteristics of a business system are related to the concept of **Ultrastability**

By ultrastability I mean adaptation to a constantly changing environment through the processes of learning and innovation. This is not a trivial idea. In order to survive at all, an organisation must display learning and innovative behaviour. This leads to the question.

- *How to create an internal environment and a set of management policies which will encourage learning and innovation?*

This and many other questions are management cybernetic problems deriving from the issue of maintaining a system's steady state when it has been subjected to either internal or external environmental disturbances, or both

Innovation, learning and problem solving are closely associated processes. Let me outline them below

Innovation is a subtle concept. When a business enterprise or any organisation uses a new method or input to produce goods or services, it makes a technical change. The process of using a new method or input is known as innovation. For instance the pertinent use of microcomputers in business is an innovation. To quote Sir Geoffrey Vickers " (1) by changing its organisation as the manager changed the organisation of his supplies department;
(2) by changing what may loosely be called its culture, in particular the mutual expectations and self-expectations of its members or
(3) by changing its personnel
All these are avenues of possible *innovation*

Margaret Boden (1977) points out that **learning** is primarily a process of accepting new information, and integrating it into a pre-existing structure. She goes on to add that sometimes it is a matter of reorganising the information that is already in the mind. Professor George (1970) describes *learning* as the process of adapting to changing circumstances and the recording of success and failure in the process. He emphasizes that without storing information gained from adaptive processes in action, learning would not be possible

Remember that both learning and innovation involve information feedback

The author (background) at a seminar for training specialists from industry

without which neither learning nor innovation would be possible in any organisation. The whole matter is complicated because a system's reaction to an innovation depends on the perception of individuals and groups within it – here perception entails receiving information from the appropriate sources. Learning involves past experience which may help the learner in acquiring quick and appropriate responses to stimuli. The process of giving appropriate responses to a new situation is **problem solving**. By a new situation I mean a problematic situation for instance sales forecasting for the Middle East market for the next year. This is a 'new' situation for the management scientist as the marketing conditions in that area are mingled with political situations and other variables. In this case the problem solver (management scientist) who will tackle this problem may be guided by his past experience – success and failure in terms of model building etc

If management solely depends upon its past successes and failures in problem solving it would not try any new ideas and methods. It would always rely on previous techniques in handling situations which are complex (due to changing environment) and which require *new* ideas and methods, and this can upset the organisation system's steady state. It is the same old story "My boss would not allow me to use this technique " I have heard it so many times that I have made countless attempts to get senior executives to learn the new science of management on my post-experience programmes so that they can create an internal environment and a set of management policies which will encourage innovation of the survival type

Types of Innovation

1. Long range innovation – this is innovation of very complex systems such as telephone communication networks, automatic weapon systems etc. Such innovations take place over a long period of time
2. Breakthrough innovation this is often the result of independent research carried out by outside organisations and may turn out to change the character of many types of industry commerce and government agencies. For instance the innovation of microcomputers is such a breakthrough it may revolutionise the data processing profession
3. Survival innovation this is an ordinary technical change which is essential for the survival of an organisation. Without it an organistion can die. For instance if XYZ's competitors are using microcomputers in controlling their product processes enabling them to deliver goods on time it is essential for XYZ to also do so and improve goods and delivery time

Complexity

A business system is immensely complex. Let me now examine the idea of complexity in the context of management cybernetics. The relationship between an organisation and its environment is complex and as yet not very well conceptualised. It raises an important question

- What relationships considered important within a business system and across its boundary make the business system exceedingly complex?

The argument for a cybernetic concept of organisation is that the environment within which an organisation operates is becoming increasingly unstable and it is increasingly difficult to define the system boundary and the size of its environment. A system analyst should seek to explore qeustions such as

- Is the relevant environment society as a whole the economic and political system other enterprises in the same market trade unions and the immediate community?
- What is the wider commercial economical social and political environment in which the business will operate?
- Where does a business enterprise's concern with its suppliers of materials machinery money and employees leave off and its concern for the community begin?

The cybernetic analysis of environment at a given point in time will reveal the *variety* which acts upon a business system. The measure of complexity is known in cybernetics as 'variety'. Stafford Beer whose contribution to management cybernetics has already been acknowledged in this series defines
Variety as the number of possible states of whatever it is whose complexity we want to measure

This concept is valuable but difficult to grasp I will make an attempt to explain it later in this article At this stage it should be borne in mind that as long as we can be sure that all of the variety in the environment cannot be included in the analysis of a business system there will always be an infinite number of models of the environment under investigation

Internal Interaction

In pursuance of the organisational mission a large number of objectives such as good relations with employees, better quality control, reliable means of communicating information, are carried out by a large number of sub systems within the organisation These sub systems interact in such a way that in the pragmatic sense the whole is more than their aggregate Therefore in the presence of rules instructions and procedures which make the system work it is hardly surprising to know that it is no trivial matter to infer the 'whole' system Thus the variety generated due to

- the internal connectivity of sub-systems and hierachy of sub systems
- the internal relationships between individuals within their own sub-systems and with individuals in other sub systems
- the interaction between the formal organisation and various informal groups
- the overlapping of sub-system boundaries
- the individual's expectations and aspirations

Cybernetics

- the interactions between how an individual is inducted into the organisation, and trained and assigned to his duties
- the interaction between management and trade unions
- the interaction between the value systems of managers

is very high and it must be controlled so as

- to recognise the complexity
- to describe the complexity
- to handle the complexity

in order to improve the performance of a system The complexity as described above turns out to be so important that to ignore it and to design control mechanisms which cannot deal with it is to rob the system of its viability

Proliferation of variety

Consider a board of directors of a small limited company which consists of five members At the board meeting each member has 'X' number of opinions about the situation under review and each of the opinions has only two possible answers (states) Yes or No This can be expressed as the total variety of the board at a particular time and thus it can be defined mathematically $V = (2^5) = 32$ This measure implies that the board as a system has 32 possible states to choose from in their decision making It should be noted that some of these will be similar Assume that the board's decision has been conveyed to 40 employees who have to be consulted about the situation under consideration In this case, the variety (of simple yes or no reactions) is $V = 2^{40} = 1\,099\,511\,627\,776$

This simple (not to say simplistic) example demonstrates that the variety proliferates and becomes impossible to cope with The variety concept is very valuable in identifying the structure and behaviour of a system for instance in learning about the number of distinguishable entities present in a system and in the ways they can behave

It should be emphasized here that our inability to totally understand the system and in practice to measure the total variety and control the 'flow of variety' leads to system design that does not act as an ultrastable system In practice all of the variety cannot be measured, as social systems do not lend themselves to such a measurement Control and regulation can be regarded as the process of controlling the flow of variety ■

- To be continued

Saeed Sheikh is a management cybernetician and Consultant

[illegible]

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BYTE SHOP COMPUTERLAND

Logitek and the Altos

This interview with Jim Pickup of Logitek, a distributor of Altos machines, is the first of a series on the trade. Among other interviews in future issues will be ones with a manufacturer and an owner of a small computer bureau.

Jim Pickup: First of all, we are the sole distributors of the Altos and sell through a network in the U.K. In Ireland, we looked at someone big enough to be able to set up its own dealer network, and we've made an arrangement with the computing side of the Guinness Group. In the U.K. we sell to very large OEMs.

Solomon. Can you define "OEM"?

Pickup: It's a very misused term. OEMs enhance the value of a machine – put their own logos on it, sell their own system. For instance, Unichem puts the PRIDE name on an Altos – it's configured specially for pharmacists. Even in hardware they use, for example, a VDU and printer we supply and which isn't part of our normal business system. In software, they have their own specialised packages. We sell them a lot of machines – and we're looking for more people like Unichem. They're very hard to come by!

Solomon: Why?

Pickup: It may be that we've been too busy establishing a distributor net and haven't openly asked for OEM enquiries. We're beginning on that. When we first started the distribution net, I looked at Commodore's list and divided it by three. Then I whittled it down to twenty five. All sell the Altos, but only some take the software offered by our subsidiary Interface Software in Camberley. Others offer their own. We run into a problem when advertising the Logitek business system proper — because that includes Interface software. We can only put in the names of dealers who take the complete system – Altos plus software. Some dealers are in the scientific market, some in the business systems market, and some in the vertical market – insurance broking, opticians, medical ... and I think these are the people who are going to win in this game – they have software aimed at a specific sector. These specialists advertise to keep an image because, in a sense, they are preaching to the converted.

I think there's going to be a very high death rate in the computer game. There are over 450 manufacturers of micros, and it would seem that the little boys are going to have their garden sheds collapse around them. We're here to stay.

Solomon: Why do you feel that?

Pickup: Well, it's because we're part of a fair sized group. We're not just in computers. We approached it all from very much a business angle. One of our companies is the country's largest motorway crash barrier and fencing contractors. We've looked at other businesses to take up any slack that might occur in that area.

Solomon: How did you get into computers?

Pickup: We started to diversify about five years ago. We bought some new premises which had a garage attached. So we started what turned out to be a very large vehicle hire company. We've also started a motor factors and an engine renovating company. All of them are running very nicely now. Our construction side will continue but it's bound to tail off slightly because motorways have reached their summit. Two years ago we acquired an electronics company and one making electrical measuring instruments, both of them in Glasgow. The electronics company was already a specialist in designing and making electronic components to order – one offs. We changed that, and have invested heavily to enable it to do sub-contracting in printed circuit work. Two years ago, Peter Warburton, who is the Chairman of the Group, and myself invested some private money in a Commodore dealership to enable someone else to start. That went very well. But we decided to do things in a bigger way and looked for a machine that satisfied our standards. Peter and another director went over to the States to talk with three companies. Having got there, they discovered that others had beaten them to it. The Altos was recommended while they were out there. They visited Altos, which is in fact owned by an Englishman, Dave Jackson — ex-Doncaster and Imperial College, London. He set up Altos about three years ago. It's a very fast growing company, and it's just moved into new premises in San Jose, California. We looked at the Altos, and liked both the machine and the people. At the time the Altos had a very high reputation for reliability, and this has certainly been confirmed by the ones we've sold.

Solomon: When you went down and saw Jackson, did you take an electronics expert, a computer expert with you?

Pickup: No.

Solomon: What kind of questions did you ask? Or was it a question of trusting a man?

Pickup: No. Subsequent to deciding we liked the company, we sent our electronics expert on a number of visits. We're responsible for supporting the machine and for training the maintenance people — DDT Maintenance — so we made sure that our people were trained first. And now, with hindsight, we would never have looked at the other machines had we known about Altos then.

Solomon: So you consider yourself fortunate.

Pickup: We're very happy indeed. People still compare single board computers with S100 bus machines. I'm not a computer man, but I can tell you that people haven't yet realised the reliability that's inherent in single board machines. There are good reasons, certainly in multi-user situations, why S100 bus machines are not suitable. And from the feedback our distributors gave us, I feel that multi-user systems are the trend. We've got packages in the pipe-line that will enable the Altos to talk to an IBM mainframe — and that will be newsworthy!

One of the problems is that there are too many big names that sell other people's machines with their own names stuck on and I do think the end user tends to go for the big name.

Solomon That's a good point. The backing of a big name. Would you say that a company like Logitek would or could give as good a backing?

Pickup Without a doubt. We always try to deliver ex stock. We spend a lot of money training our engineers. And though I'm not saying this is new, we feel that a lot of people aren't doing it the way we are. We've arranged maintenance — in the field — with DDT Maintenance in Boreham Wood. We're satisfied with them as they've expanded to meet the increased business we're giving them. They're also supporting the Altos in Ireland. To answer your question further — we sell to dealers and they know their job. People prefer to buy from and be supported by a local expert and we in turn support him.

Solomon All right, you said local expert. What are your criteria for selecting dealers?

Pickup First, they have to be financially sound. That isn't always the easiest thing to establish — which is why we prefer established people with a track record of successfully selling other people's products. It's very easy in this game to sell machines to the knowledgeable but the successful dealers — in the long term — are those who set themselves a marketing and sales plan to cope with the time the supply of expert buyers runs out. And here software for the untrained *user* is the key. The bare bones of the software that our subsidiary, Interface Software, supplies, comes from Retail Sciences in America. Interface has tailored this software so much so that now there's an export market for it. We don't believe in moving fast in every direction at once. We're always in control. But all the same, things have moved very fast since we started in December 1979 – far faster than we expected, even with the benefit of our experience of the private venture I earlier talked about. But we were well set up to do even more business than we are at present doing.

Solomon You were amazed but not surprised. And you've had no supply problems?

Pickup None. You know, Altos also supply single drive machines but we don't stock these as a matter of course. We've also steered away from double sided drives because...

Solomon ... Of reliability problems.

Pickup Yes, in the past. Altos don't deny that, but these are not problems of the products they manufacture. We're evaluating new Shugart drives right now. But the Altos machine we stock plenty of – you can call it our bread-and-butter machine – is the single sided double drive, one megabyte machine with 64K RAM. In the case of the multi-user system, it's more difficult to predict demand. We ask our dealers to let us know well in advance — but without any obligation to buy – what they think they're going to require. We want never to be in a position where we have a demand we can't supply. In the case of the standard system, of course, we have no problems with stock.

On the business side, all our dealers who sell the business system have to have a demonstration unit and be fully conversant with business needs, and be able to talk in the businessman's language. All our business systems have the full range of packages supported by Interface Software. We emphasize support. That and efficient software are now the most important things around. We are very anxious that the Altos has a good name. We'll bend over backwards to support our dealers and, through them, our customers. As I said, we intend to be around for a long time. Software is the key. Instilling confidence in the product leads to sales. And that is what it's all about. ■

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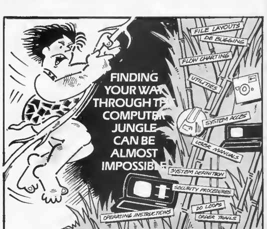

The new BIM "Hands on" seminar "Getting to grips with Mini and Micro-computers" is a good way to start.

This two-day intensive course incorporates hands-on experience using microcomputers and is suitable for all managers, accountants, businessmen and consultants. The course removes the jargon barrier explains how computers work and demonstrates what you can achieve with them The next public courses are on **22/23 September, 7/8 October, 12/13 November, 19/20 January and 19/20 February** The course is also now available on an in-house basis. Numbers will be restricted to a maximum of 33 participants so that each individual can have the opportunity to write and test his own programmes.

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GETTING TO GRIPS

. . . with the British Institute of Management

INTRODUCTION

The British Institute of Management's aim is to promote the highest professional standards in management Its fast growing individual membership comprises over 70 000 managers including accountants engineers production and marketing executives hospital administrators, local and national government officials Over 12 000 member organisations are drawn from every type of company and enterprise

BIM is the central national source of management information and has made a major contribution to the rapid development of management education

Established in 1947 BIM is autonomous self financing and free of all external controls Its policy is controlled by an elected national council which has power to co-opt where specialist advice is needed The Institute's membership structure provides a mechanism for all members to voice their views and influence the development of BIM policies and attitudes

REGULAR JOURNALS

A personal copy of the following journals is sent to individual members

- *MANAGEMENT REVIEW AND DIGEST* (quarterly) provides management abstracts research news, articles on a wide range of management subjects, BIM News reviews of new BIM publications library and information news branch activities book and film reviews etc
- *MANAGEMENT TODAY* (monthly) The most widely read business magazine in the UK which carries a special section on BIM policies and activities

PUBLICATIONS

A catalogue of BIM publications and services is available

- *MANAGEMENT CHECKLISTS* which focus on a variety of management problems by asking key questions
- *MANAGEMENT INFORMATION SHEETS* – concise guides to subjects of topical interest
- *BIM REPORTS AND SURVEYS* often based on original research provide a valuable and concise summary of current management practice

BIM'S MISSION

One of BIM's most important tasks is to help managers and managements improve their performance and business results A wide range of information and advisory services are based at Management House in London including a management library and specialised departments dealing with specific needs

BIM's Management Development and Training Services Division receives frequent requests for help from organisations – often leading to interventions of one kind or another In addition to a growing In Company service – providing advice learning programmes and systems over a wide range of management development and training needs – this division organises regular public programmes in the form of 1 or 2-day seminars – conferences and special workshops residential courses known collectively as the Oxford Management Programmes

BIM

The regular short programmes aim to cover a fairly comprehensive range of managerial and functional needs Some are concerned with cross functional appreciation – such as MARKETING FOR THE NON MARKETING MANAGER and FINANCE FOR THE NON SPECIALIST Others deal with personal skills such as EFFECTIVE SPEAKING READING & REPORT WRITING NEGOTIATING WITH TRADE UNIONS, SELECTION INTERVIEWING and TRAINING THE TRAINER A further group is concerned with commercial aspects such as CASH MANAGEMENT and STOCK MANAGEMENT HOW MUCH STOCK – AT WHAT COST? Aspects of manpower planning and development are covered in DESIGNING AND IMPLEMENTING YOUR MANAGEMENT DEVELOPMENT SYSTEM, AN APPROACH TO SUPERVISOR TRAINING and the TRAINING FILMS FORUM Legal aspects are explored in such seminars as COMPANY DIRECTORS RISKS RESPONSIBILITIES AND THE LAW and a problem that affects managers in ALL functions is tackled in the 2 day course TIME MANAGEMENT AND PERSONAL PLANNING

Managerial effectiveness itself requires rather longer treatment and is most frequently tackled in house with programmes of between three and five days duration THE EFFECTIVE MANAGER is organised regularly throughout the United Kingdom and covers the following aspects

- What is Management? The processes involved
- Human Needs and Motivations
- Management Style – analysing one's own style
- Management Situations the flexible approach
- Communication The processes exploration of the barriers to effective communication
- Personal Interaction and Handling conflict
- Meetings a special form of communication
- Managing Time the scarce commodity
- Developing People ways and means
- Job Reviews and Appraisals
- Organisation principles and their relevance to effective communication and staff relationships
- Management Thinking Processes Creative thinking and the brainstorming technique
- Groups and Teams team leadership
- Rapid Reading – Introduction to the techniques
- Decision Making – technical and human factors
- Managerial Effectiveness – how to achieve it by putting theory and experience to work Action plans for the individual for the team

The Oxford Programmes include MODERN MANAGEMENT (BIM's Foundation Course) and its counterpart MANAGEMENT ACCOUNTING FOR BETTER DECISIONS AND CONTROL both courses being most suitable for experienced middle-to-senior managers

So much for some of the on going activities expected of BIM by its regular customers In addition we believe it is our role to select issues of particular concern at the given time for special – sometimes intensive – treatment Such priorities relate to our national performance as a whole where managers are concerned

Over the past eighteen months we have been pursuing two main objectives – which are in reality twin pillars of equal importance in the building of better results

The first pillar is that of new technology – understanding it and applying it The second is improving the management of people – the people on whom we rely if new technology is to be introduced successfully and quickly Our national record in applying new technologies is poor Our mission can be summarised in the simple equation TECHNOLOGY AND PEOPLE = WEALTH CREATION = PROSPERITY

We have constantly emphasised the need to put people into the centre of the scheme of things Too often work systems are devised and then people fitted into them

The question of managerial style – in particular the need for more consultative and participative styles to engage the co-operation and energies of people at work – is constantly emphasised in programmes such as PARTICIPATION WHERE IT COUNTS (based on a recent BIM research publication) and the regular seminar MANAGING CORPORATE COMMUNICATION

By far the greatest number of recent activities has been concerned with micro electronic technologies – their nature potential, commercial impacts and human repercussions We believe that talk of the 'revolutionary' impact of microprocessors (on work jobs society and the world at large) is NOT exaggerated, as some have claimed

Activities

We first tackled the task at the awareness level by organising a repeated series of conferences covering the USES OF MICROPROCESSORS MICROPROCESSORS IN PRODUCTS AND PRODUCTION, WORD PROCESSING – SYSTEMS AND PEOPLE and MICROS – INFORMATION AND CONTROL Conferences on ROBOTS AND THE FACTORY OF THE FUTURE were complemented by a series on THE OFFICE OF THE FUTURE The next step after this spreading of the word took us into our present more active and more specific mode – the acquisition of practical working knowledge and some basic skills through "hands-on' experience

Some of the BIM Study Tour Group discussing an information system in Boston

GETTING TO GRIPS

GETTING TO GRIPS WITH MINI AND MICRO COMPUTERS a two-day course has enjoyed a considerable success since it was launched in March of this year

New microelectronic technology is changing all kinds of organisations Tomorrow's businessman will need to be much more familiar with computers because their power is now cost accessible to even the smallest business or department and few can afford to ignore these new power tools

BIM had identified a gap in the provision of help and is now filling it with this two day programme It has become a regular component of BIM s management development programmes being designed for managers from all functions and levels (excluding computer specialists) accountants and all businessmen seeking to cut costs whilst improving both efficiency quality and timeliness of management information with small computers

It aims to provide a thorough understanding of the nature and potential uses of the new generation of small computers and to deepen this understanding by coaching participants in basic programming In this way the participants are given hands on experience with small computers and by the end of the programme they are able to write their own sample programs test them de bug them and use them for their own particular requirements

Of course in these two days we can hardly turn managers into programmers but through the hands on experience managers learn that one does not have to be a computer specialist to be able to gain substantial advantage from small computers In fact the emphasis is placed on the hands on element for a number of reasons – one of the most important being to eliminate computer phobia The fear of computers which was originally cultivated by the computer profession in the old days is no longer relevant because today small machines are a lot more reliable and a lot easier to use than they were even five years ago The right attitude towards computing is really the only criterion necessary to be able to use these machines

In addition this course explains what a computer is and how it works It gives non computer people the necessary background to make intelligent decisions about computers A case study is used to demonstrate to the participants how to manage the size of computer necessary to do a particular task This sizing of computers is one of the most important aspects which a would be computer user should be familiar with Disc capacity printer speeds and the number of terminals necessary are all investigated and the participants are made aware of the range of computer suppliers who can satisfy particular requirement

Computer jargon and technical mystery are explained so that managers can decide for themselves how they can best use a machine rather than relying on technical departments or computer salesmen

The programme is practically oriented with ample opportunity for discussing the individual manager s computer requirements Numbers are restricted to a maximum of 33 participants so that each can have the opportunity of writing and testing his own programmes In fact participants have become so engrossed with their programmes that the timetable has been altered to provide a working lunch in addition to making the computers available into the evening!

This event is also in demand on an in company basis, when it can be tailored for the particular organisation and it has been accredited with twenty hours for CPE (Continuing Professional Education) by the Institute of Chartered Accountants in England and Wales

A further stage moves us on toward interventions within the enterprise The programme is called CAN YOU USE A MICROPROCESSOR IN YOUR OPERATION? It is an in house diagnostic package (although one which can be varied at will) consisting of four parts

1 The operations of the company are explored during field work in preparation for
2 A briefing day concentrating on the likely areas for microprocessor applications in the firm This leads to

3 Project work backed by checklists for guidance (given at stage 2) under the heading 'The Search for Applications'
4 Debriefing and Action Workshops then initiate the necessary planning for full scale feasibility and implementation

U S TOURS

A further type of activity has recently been added – The Study Mission The first tour to the USA took place in June – a preparatory to a major series in the Autumn This type of treatment can be described as going to see for oneself but also provides access to the line managers and operatives actually involved at the sharp end of business

One of the quickest ways of acquiring information on the current state of the art in the mini and microcomputer world is to visit leading edge suppliers and users in their home territory This is particularly true in the area of information and control technology which is rapidly changing due to advances in hardware and software This study tour is specifically concerned with surveying these latest developments

On June 10 British business managers went on BIM's study tour to New York and Boston where they were exposed to a wide range of equipment

The objectives of this series of study tours are

1 To help participants relate newly available technology to the needs of their own businesses

Activities

2 To provide a wide [illegible] of trends in this field as a basis for future thinking

The October study tour will concentrate on the following issues

1 Word processing electronic mail stand alone and shared logic systems
2 Data processing distributed concepts use of front end processors and concentraters
3 Distributed processing opportunities through use of micros in general and shop floor control equipment specifically
4 The use of point of sale and electronic funds transfer equipment
5 User and supplier attitudes towards training installation return on investment etc

The suppliers and users to be visited include Vydec, Data Pathing, Raytheon Wang, Exxon and Citicorp

A very marked interest is being shown in these US tours by a wide range of UK companies We expect an equal interest in BIM's (second) mission to Japan, which will cover Industrial Robots and Automation (both current and advanced) In three major industrial centres (The rate of application of new manufacturing technologies is higher in Japan than almost anywhere else)

The mission to Japan will be of two weeks duration in total (10-25 October) and will be intensive and far ranging, within the following objectives

1 To review current applications of robots and related automation across a wide variety of manufacturing and distribution tasks and industries
2 To look into the future of automation by visiting a number of very advanced application areas

With these missions we are confident that we are responding to a major need in an effective way The opportunity to gain so much new knowledge in this field – and to discuss developments with interested fellow travellers – should lead to earlier applications in UK industry although naturally the whole subject must be properly related both to UK and company contexts

Throughout these successive stages we achieve increasing levels of involvement but need more time and even smaller numbers to achieve the very best results For each learning event we mount, we begin with careful analysis of our aims – generally multiple aims for any major public programme has, by its very nature, to offer something of worth to a wide spectrum of interests While public self-financing activities can never be geared as specifically as the equivalent in-house programme, such conferences must nowadays provide much more than exhortation, generalised statements in favour of virtue – and a day away from the job They must provide solid practical help based on real experience and the latest thinking and developments – especially in the exploding area of new microelectronic applications ■

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Purchase & Nominal Ledger

Richard Walker is with Spr[illegible] [illegible] Management Consultants

Companies in a small way of business keep their purchase records in an analysed cash book. Three columns on the left hand DEBIT side show the cash received with a note of the discount allowed and the VAT About 15 columns on the right-hand CREDIT side show cash paid discount received with the detail (cash plus discount less VAT) analysed in appropriate columns The right most column is used for all the non recurring unusual oddments like new cars and audit fees At the end of the year add it all up, agree it with the bank statement, then figure out ACCRUALS for electricity bills not yet received, and PREPAYMENTS for rent and rates paid in advance Total again and cross-cast to see there are no mistakes and produce a sample income and expenditure statement and balance sheet All in one book Neat effective

The following five things push you towards a more sophisticated system of book keeping Maybe just one is urgent enough to push you forward to a proper **Purchase Ledger**

1 Too many suppliers or too many invoices or both There comes a point where manually ticking off piles of invoices against suppliers statements becomes a chore And when several of the invoices have queries the alterations to the supplier's statement make it look like my under five year-old daughter s school book.

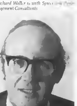
2. You are losing settlement discounts because you keep forgetting to pay within the due time or the bank overdraft is too large because you are paying some invoices *too soon*

3 Analysis of purchases to nominal ledger headings is too complex for a ruled cash analysis book

4. Separate departments companies or branches require cost analysis to better control their own affairs

5 Quarterly or perhaps monthly operating statements require more specific monthly or year to date figures

So to do all these things a big, thick, loose-leaf ledger is started with a page for each supplier And another ledger will have a page for each nominal expense analysis account, and for each branch or department separate pages for all the accounts for which there are expenses



The INVOICES for goods purchased and showing the VAT are recorded in a DAY BOOK and then posted to the LEDGERS The CASH BOOK now only shows cash received and paid with the discount and is in turn posted to the sales or purchase ledger CREDITS received for goods missing or damaged are entered in a separate day book A JOURNAL with debit and credit columns and space to write the explanatory narrative is used to sort out mistakes

The same procedures are necessary as previously for checking invoices received Someone has to see that the goods have actually arrived, that they are what was ordered and they are not damaged in transit The price trade discount VAT rate and all the arithmetic has to be checked and a note made on the invoice of the supplier ledger account number, the order number, and the nominal analysis codes It is usual to put a rubber stamp on the invoice so that the checker can note codes and tick off items as they are checked.

The supplier's statement tends to get ignored We should check that it is correct so that we can tell him how to keep his ledger in accordance with ours But life is too short, let him solve his own ledger problems Instead we make out our own REMITTANCE ADVICE to send with the cheque detailing all the invoices we are paying The amount of cash and discount is posted to the ledger and allocated against the invoices paid these items are then no longer of interest to us only to the auditors at the end of the year

At the end of each month the book keeper must balance the ledger adding up each account, noting it on a list of creditors, and then checking that the total reconciles to a CONTROL ACCOUNT where the daily totals of transactions posted and opening and closing creditors should agree

For the **Nominal Ledger**, you need to take *each* item that has been posted to the purchase ledger and post it *again* either in detail or in summary to an appropriate expense account A monthly TRIAL BALANCE listing should agree debits should equal the credits If it doesn t then something has not been posted

At the year end the Trial Balance is updated with accruals and prepayments to produce an annual Trading Account Profit and Loss Account Balance Sheet and Source and Application of Funds statement These documents must look consistent from year to year show comparative figures from last year and be beautifully typed so that you are proud to show them to the Directors, and the Bank Manager and the taxman A much abbreviated statement emphasising the achievements of the year in a Directors Report goes to the shareholders the Press and perhaps to the *Financial Times* competition for the best-presented set of accounts

All this is governed by aesthetic judgement and almost more care goes into the presentation of the figures than went into the accuracy of the ledgers on which it is alleged they are based There is some control over all this The shareholders employ an Auditor who is required to state whether, in his view the accounts do present a true and fair view of the concern s state of affairs

New computer users start here

There is not normally too much rush about Purchase and Nominal Ledgers A posting session once a day or even once a week, will do fine. So all the input is gathered into batches of not more than 50 items at the most, usually much less, and then keyed in, invoice by invoice and cash payment by cash payment. Each batch is added up on an adding machine, and the computer programs have to agree back to the prelisted total before going on any further. Journals must similarly agree debit to credit.

Once agreed, the whole batch is listed for reference and then posted automatically to the purchase ledger. At suitable intervals, at least monthly, the whole of the input is printed for a permanent hard-copy Day Book record. At least monthly, the total of the day book is analysed to nominal ledger codes and then posted automatically to the Nominal Ledger, either in detail or in summary form, one total for each code. Once this has been done the detail day book record on the computer is then no longer required and can be purged.

From then on the computer can assist significantly. Programs can select *items for payment* just before the due date, can make out *remittance advices* and *cheques*, can list the *outstanding debtors*, and reconcile the *control accounts*.

On the Nominal side the programs can balance the *ledger*, *print operating statements* and theoretically can even type the *final accounts* beautifully for the Board of Directors practically untouched by hand.

But it does pay to review the results at each step, just to check nothing wrong has crept in. Misquoted codes at the data entry stage can have quite interesting results in the final figures. The time to notice such errors is when they are first printed, when they are easy to change.

CAP-CPP MicroProducts Ltd

CAP CPP invented MicroCobol. It is substantially based on ANS COBOL with a number of additional features to make program development easier and faster on micros. MicroCobol is a programmers' language. It has facilities to produce better documentation than most versions of BASIC, and this is the key to the long life of programs and protection of your software investment.

Besides Purchase and Nominal Ledgers the application programs produced by CAP-CPP include Invoicing, Stock Control, Payroll, AutoClerk, AutoIndex, and, promised for the end of 1980, a Word Processing package. All these programs are written in MicroCobol and therefore run unchanged and without any recompilation on some 21 different manufacturers' machines. (See end of article)

A feature of the software is the excellent user documentation. The packages and the documentation are available from agents who are totally responsible for installing and maintaining the computer hardware and the software, only referring to CAP in case of difficulty. There are 39 agents in the UK, plus 14 in the US selling a separate range of MicroCobol products, and 13 in Europe and Australia, normally selling only the development software. The list of supported machines and agents changes day by day. Contact CAP CPP on 01-404-0911 for a list.

Purchase and Nominal Ledgers are sold together in the UK for £1000 plus 15% maintenance after the first year. Allowing for demonstration units at agents, and systems sold but not yet installed, probably 50 are actually being "used in anger".

How it comes

The software is delivered by your agent on the appropriate media for your system. The ledgers each come on four standard 8" floppies or three double density floppies or a single exchangeable hard disk. On one of the floppies is a sample set of demonstration data for in house training and experiment before loading the company data in earnest. All the examples in the manuals are referenced to data on the sample files, and each example should be *practised* on the machine *while reading the manual*.

The new user is exhorted to take copies of the programs and the data before he does anything else. The procedures for backing up files and programs and, if necessary, for restoring data from backup, is built into the software provided, and is a major emphasis throughout the operating procedures.

The agent will normally provide a couple of days training. If you screw him for a discount it is this training and after sales support that suffer. Most agents now know to budget for adequate user support when quoting prices. After half a day's supervised operation, most users find that private study and practice is enough, needing only a few telephone calls to the agent.

Setting up data

Once the user is familiar with the system it will take a few days to nominate the options required and set up the file sizes. It will be well to keep some of the agent's support days in hand for advice at this stage. After setting up the files it is not easy to change your mind. There is a section at the end of the manual that may help. But if you are determined to change your mind you may have to scrub the lot and start over.

A Global file records the options, company name and address, banker's name and address. Supplier files have much more detail and include a supplier type code for any required special analysis, priority code to identify important people to pay first, settlement discount percent and period, normal settlement period, options to pay by cheque or credit transfer and a No Pay code to with hold payment temporarily. The file also contains four balance amounts for quick reference by an enquiry program. A separate file has the supplier name and address, and yet another has the supplier's bank name, address, and code for payments by credit transfer. You can add more suppliers at any time. And providing nothing is owing to a supplier, you can delete a supplier's record at any time to provide more space. The standard 8" floppy will hold around 200 suppliers and 100 transactions, bigger floppies hold more.

Setting up these files is by keying against prompts on the display screen. There is a lot of data. You may not achieve more than a dozen items an hour so it is going to take some time. But it only has to be done once.

In the Nominal Ledger there is the need to set up the Chart of Accounts, the codes and names of the expense and revenue analysis headings you need. If you already have an existing Chart for your manual ledger this is easy. If you have to compose a new set from scratch, then the discussion/argument/changes of mind are apt to take several days. It will involve detailed discussion of the sort of operating statements, accounts and balance sheet you need to control your business. This activity used to be called systems analysis and was done with the aid of professional accountants or systems people. This help may be a good idea for you.

Entering data

Once the files are set up, entering the transactions from day to day is quite straight forward. On the CAP-CPP package, invoices are logged onto the computer as soon as they arrive in the company. There is some manual editing first, the supplier number has to be looked up, either using the index on the computer or a manual card-index or computer listing. Using the computer index you need only key a few characters of the name, if there is only one supplier that matches that name, then the full name and address is displayed for visual check, and thus gives the supplier number to be noted on the invoice. If there are several suppliers that match, they are all listed so you can select the one you want.

Key in the supplier number and the invoice details as far as possible. The system allocates a unique reference code for that invoice and this too should be written onto the invoice. Once logged you can send the invoice out to the man who ordered the goods for him to approve. Note his initials on the computer record so you know who to chase.

When the invoice comes back, key in the supplier code and the unique reference. The program displays all the detail, any item can be changed, the nominal analysis codes are keyed in, and when correct, the invoice is marked as approved. If you know the invoice was correct originally then the detail can be entered and approved in one operation. At any time the invoices that are not yet approved can be printed so you can progress them.

Only approved invoices will be posted automatically to the ledger. Credits have to be approved in the same way, but when posted can also be allocated against invoices, and then both invoice and credit will be disregarded on the payment system.

The system is sensitive to dates. If the previous month has not yet been closed off, and also the invoice data is prior to the month end, it will go into that period If after, it goes into the current period You can thus keep the previous period open well into the following month to capture all possible transactions before the period end

Auto payment

You can pay cheques manually at any time After this manual payment plus the settlement discount is posted you can allocate it to specific invoices which will serve to rule off both sides from the record If not allocated then the payment is treated as a payment on account and shown as a deduction on any subsequent remittance advice printed

Similarly, Journal entries can be used to correct errors in posting, enter special rebates, write off balances, or handle contra items to set off sales ledger balances against purchase ledger outstandings If these are allocated then they are ruled off and will not print on subsequent remittance advices

Automatic payment is in three phases The company acountant will want to have a say at each phase Firstly, to have the program go right through the ledger and identify all the items that should be paid up to the specified data Secondly to have the accountant look at each item and try and cut the list down to the total amount of money available for paying cheques today Thirdly to have the computer programs prepare remittance advices cheques, and credit transfers and to rule all the items paid off the file

The Provisional Payments List therefore sets out all the invoices due for payment on the specified date This date should be some few days into the future, since it takes time to print and sign cheques and

to post them to the supplier Miss the date and you lose the discount

Temporary amendments are then made by the accountant to postpone payment of particular invoices, or suppliers (perhaps according to the type of priority codes entered on the record), or groups of companies Amendments can also reduce particular invoice totals for queried items, or contrariwise, cut out settlement discount if it is too late to be claimed

Normally the accountant will require a rerun of the provisional payment list to check that the total now to be paid is in line with his available cash Once the go ahead is given the special stationery can be loaded into the printer for firstly remittance advices then for credit transfers then for cheques A plain paper list is printed for the bank for the credit transfers Printing is assisted by the print-set up program for each printout that uses special stationery A line of * s is printed as often as required There will be a couple of sheets wasted Printing cheques means that wasted cheques must be accounted for They must be pre-numbered of course by the printer The mind reels at the possibility for fraud if you don t take care

Balancing the purchase ledger

A purchase ledger trial balance program lists all the suppliers and the amounts outstanding or in credit A separate report prints a control account showing the totals of each type of entry posted since the beginning of the period The control account balance and the list of creditors should agree

If further detail is required the Purchase Ledger Print program gives this It is necessary to print this each month, anyway as a permanent hard-copy record of the ledger for the archives Items which have been paid and ruled off will still print out the listing until physically purged off at month's end

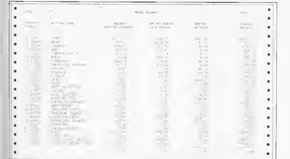
Cost-centre analysis

If you have been entering an additional cost-centre analysis code on some or all of the invoices then a special program is available to sort and list these All these reports use another CAP CPP package called AutoClerk during program development This is a very quick and easy way to format reports or change existing ones I think, to make any real use of the cost-centre data, you would be wise to buy a copy of AutoClerk and to massage the reports as you want them But if a straight list of items sorted by cost-centre code and with group totals will help you then it is all yours

As an alternative you can code cost centres into company codes (1 9) and department codes (1 99) and have the programs post the items in detail to the nominal ledger The operating statement programs in the nominal package will format them in a rather more useful way and compare items with budgets if needed

Posting to the nominal ledger

At the end of the month, once the purchase ledger is balanced, the accumulated nominal ledger analysis is sorted and run against the chart of accounts to validate the entries Any spurious codes are highlighted The identified problem codes are then resolved by journal entries in the purchase ledger and the validation



Sample Trial Balance

program rerun Once the run shows the data to be clean then the entries are posted to the ledger automatically Note that only items up to the end of the specified month s end are posted, subsequent entries are passed over

If you want to check back from the nominal ledger posting which is only a monthly summary figure to the detail then you have to go either to a monthly complete list of purchase ledger entries, or if not printed monthly then to the weekly day book lists None of these lists is in a very convenient order I think we need another AutoClerk program here to provide a proper audit trial

Befor the nominal ledger is complete it is necessary to prepare journal entries for sales ledger items and for totals of cash and discount

Nominal ledger balancing

The nominal ledger trial balance program lists the accounts and adds up the totals Providing everything has been posted right the totals of the Debit and Credit items will balance The transaction list program gives the detail if required

At the end of the year a special program takes in accruals and prepayments, and will automatically carry these forward as opening balances for the following year There are programs to set up the ledgers for the next year and carry forward the other balances It will be necessary to set up journal entries to transfer expense and revenue items to trading and profit and loss accounts before the ledger is carried forward

Final accounts

Many ledger packages on computers go no further than the Trial Balance The CAP CPP pckage also has a budget facility so you can plan ahead for each nominal account for each month An operating statement program is available where you can specify the order in which items shall be printed and group them so they can be added up Columns across the page give actual and year to date comparisons against budget with a variance and a forecasted end of year position Users however have not been too happy with this

Now CAP CPP promise a much more flexible printing option Any nominal ledger item can be nominated to a specified report On that report the line number narrative description column position and totalling will be specified There will be budgets and one hopes comparative figures from last year It sounds magnificent Probably only the enthusiasts will use it, but for them it should produce superior results

Summary

It is hard to be rude about CAP CPP packages I see so many packages with poor user documentation that anything that I get that I can actually understand gets a top rating

It is a large and well designed package There are simpler ones on the market that run on smaller machines This one works

Package

It can be demonstrated on a wide range of machines There are a sufficient number installed to allow reference to existing customers for comment Some of the machines allow hard disks and multiple terminals to provide for growth in transaction volumes There should be an agent close to you

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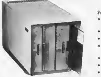

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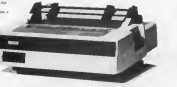

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Science horror?

The July issue carried two articles on microcomputers in medical practice Their juxtaposition was very revealing Mr Fleischmann s article was idealised science fiction hypothesising how doctors could use microcomputers, whereas Mr Mason s article clearly demonstrated how doctors will (ab)use them and is harsh reality In confronting each of many innumerable problems doctors come to grips with only the most immediate aspect of the problem they travel through a dense wood one tree at a time ' not seeing the wood for the trees Since World War II the medical profession has advanced with only a very few exceptions by using ever higher ever costlier technology to solve ever narrower ever less fruitful problems

Mr Mason s article, describing the use of a microcomputer to regulate the administration of drugs to patients suffering brain injury demonstrates this vividly The microcomputer is applied to a very narrow area of doctor patient interaction, yet severe head injuries involves not only the patient and the doctor but also the nurse the family the physiotherapist the occupational therapist the rehabilitation officer the social worker and former and prospective employers A broader approach is needed The very limited costly and unrewarding use of microcomputers thus described contrasts markedly with the broader approach to the problem of head injuries taken by Prof B Jennett in Glasgow whose computer predicts at a very early stage the outcome of a head injury enabling all those involved to come to a far better judgement as to how to manage each case This is the correct use of computers but I fear it will make but little headway in the medical profession A somewhat imperfect metaphor is that the medical profession in trying to analyse a hair uses each new technology to split that hair even more finely instead of stepping back and with a new technology take a fresh broader approach to the problem

Dr M J C Brown, Snowshill Manor Broadway, Worcestershire WR12 7JU

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Alistair Kinloch, 6 Denoon Terrace, Dundee DD2 2EL

Science in management

As an Office Manager I am very much interested in the application of Science in Management For this reason I read some journals in order to gain some insight of new developments concepts and methods

I was under the impression that cybernetics was a mathematical subject which was applied in some engineering fields Now having read two articles by Saeed Sheikh in your issues 7 and 8, I am very much convinced by the author that cybernetic thinking is extremely useful in analysing problematic situations in business

Saeed Sheikh has made it very simple for me to understand both parts in this series so far as his examples are a great help in understanding his message

May I also say that your journal has provided me with easy to understand material which is a useful source of knowledge

Good luck in your mission A useful magazine

T Haque, 14 Cannonbury Avenue, Pinner, Middx HA5 1TS

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The Helmsman

For some years I have had an interest in computers and have closely followed articles in American magazines concerning them During my short visit here to England I have been searching for computer related magazines and have discovered *Computer Age* I feel the magazine is excellently written and I have been impressed with the lucid and informative style of Mr Saeed Sheikh who has made the subject of cybernetics quite easy to follow Having read the above series in your issues 7 and 8 I am convinced that cybernetics can be applied usefully in business management

Having worked many years for a large oil company and presently now operating a business of my own I agree with Mr Sheikh that information can be distorted in business systems Therefore I think cybernetics can help immensely in designing a system

In closing I should like to wish *Computer Age* success in the future

A B Williams (Director), East Street Servicentre (Shell), P O Box N7421, Nassau, Bahamas

Lecture material (1)

May I take this opportunity of saying how impressed I am with your magazine I teach computer studies and I find it very useful for information stimulation and ideas full of 'meat Keep up the good work!

Kenneth J Harrison, Shirwin', 3 Irene Avenue, Tunstall, Stoke-on-Trent ST8 7HB

Lecture material (2)

Your magazine is certainly a very welcome newcomer to this field and as a college lecturer I have been able to incorporate some of the material into existing presentations tutorials etc

Brian S Ritchie, Flat 1 Dunavon House, Dunavon Gardens, Dundee DD3 9RA

Level headed

Excellent magazine I am a COBOL programmer and having read issues 5 and 6 you seem to have covered many areas in which I am interested at just the right level

Mr K G Bickers, 24 Upper Bognor Road, Bognor Regis, West Sussex PO21 1HT

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